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STUDENTS'
PHARMACOLOGY
AND
MATERIA MEDICA

BY

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PREFACE

No apology is needed for adding this small book to the existing stock of elaborate and trustworthy treatises on the subject of Pharmacology and Materia Medica. This book is written neither to supersede nor to compete with the text-books written by Whitla, Bruce and Dilling, Hale White, Ghosh, Cushny, Dixon and other well known authors, whose books have become popular with the students reading for their University course. These books, however, with their mass of details, prove too bulky for students preparing for their different License Examinations, as they are expected to finish their study of Pharmacology and Materia Medica, including lessons in Practical Pharmacy, in about fifty lectures. Moreover, the physiological action of drugs as treated in these books, proves difficult for these students to understand, as it presupposes a knowledge of physiology which they do not have, since according to the existing practice, the subjects pharmacology and physiology, are taught simultaneously. The material available in these standard text-books, therefore, requires a great deal of pruning without sacrificing important details, and also careful presentation in the clearest way possible. With these points in view, I had to prepare my notes before lecturing to the students of preparing the subject for their License course, and the contents of this book are nothing but my notes, culled from various books, amplified with a view to put them in a brief and easily graspable form. In the preparation of these notes standard treatises written by such authors, old and new, as Price, Binz, Lauder Brunton, Bastedo, Sollmann, Murrell, Dixon, Cushny, Poulssan, Osborne, Solish-Cohen and Githens, had to be consulted and drawn upon. I am, therefore, greatly indebted to all of them for the valuable help I have derived from their books.

The arrangement and classification of drugs has always been a difficult problem. Many drugs, particularly of the Vegetable Kingdom, possess more than one property with the same or varying doses. The group to which such should be assigned, often becomes more or less confusing. The arrangement of the medicinal substances into their respective kingdoms—Inorganic, Organic and Synthetic—and classifying them according to their pharmacological and therapeutic bases is, I believe, the best from the student's point of view. I have therefore adopted the same in the present book. The preparations from individual drugs are given in small type.

While the manuscript of this book was being prepared the new revised edition of the British Pharmacopœia was published. I have, therefore, taken advantage of the fact and written the Materia Medica on the basis of the British Pharmacopœia of 1932.

I hope the book will prove useful to the students for whom it is intended. It may also prove useful to the students of the University course for revising their subject after they have mastered it from a standard text-book, when they have very little time at their disposal to go through it again during the crowded programme of study preceding an examination.

My thanks are due to Dr. U. S. Rao, L.C.P.S., for preparing the index of the book.

April 1933. V. G. RELE.

PREFACE TO THE SECOND EDITION

In this Edition the Book is entirely reset. The Drugs have been grouped on their similarity of actions. The subject-matter has been carefully revised and brought thoroughly abreast of modern developments of Pharmacological actions. The book incorporates the Drugs of the British Pharmacopœia as amended by the Fifth Addendum 1942.

V. G. R.

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Students' Pharmacology and Materia Medica

PART I

Introduction

THE drugs, or the substance used for curing disease, are derived from inorganic and organic kingdoms. Inorganic drugs are salts of various metals such as the Tartrates, Citrates, Carbonates, Sulphates, Phosphates, Chlorates, Iodates, Oxides, and others. Organic drugs are mainly of vegetable origin; some are of animal origin ; while others are compounds artificially or synthetically prepared in a chemical laboratory. The description of these, as regards their natural history (source, origin and distribution), physical characteristics, compositions, preparations, and action on living bodies, was formerly included in the term Materia-Medica ; but owing to the rapid advance made in the knowledge of these different branches it is thought advisable to give distinctive names to these branches. The term **Materia Medica** includes at present only the knowledge of the natural history, physical characteristics and chemical properties of the drugs. The various preparations and compounds made out of these remedial agents so as to render them fit and easy for administration are together grouped under the title of

Pharmacy. The effects of these drugs on the body in health is described under **Pharmacology** or the physiological action of drugs. The effects of their administration in repeatedly small doses or in a single large dose, so as to produce poisonous symptoms in otherwise healthy individuals form their **Toxicology.** The use of drugs for the cure of diseases is their **Therapeutics.** The Therapeutics is either Empirical, Rational or General. The *Empirical* way of treating disease is based on the dictates of experience, without any explanation of the action of the drugs on the disease, *e.g.*, action of Colchicum in the cure of Gout ; while on the other hand *Rational* therapeutics presupposes a knowledge of the working of disease and of the pharmacological action of the drug and the consequent use of the drug to cure the disease, *e.g.*, Quinine in Malaria. When agents other than drugs are used for curative purposes, they are called accessory therapeutic agents. These may be hygienic, mechanical (semi-surgical) or physical (heat, light, darkness, electricity, etc.).

For the information of physicians and pharmacists an authoritative statement of the source, physio-chemical properties, doses, preparations, etc., of these remedial agents is given in a book called **Pharmacopœa,** which is prepared by a body generally constituted by law. The drugs which receive recognition in this book are called *Official* or *Officinal.* These Pharmacopœas vary in different countries and to specify a drug and its preparations according to a particular pharmacopœa, the abbreviations of the name of the country are placed after the name of the drug. In Great Britain the book containing this information is called the **British Pharmacopœa** and the authoritative body publishing it is the General Medical Council of the United Kindgom. The abbreviations placed after the preparations mentioned in the British Pharmacopœa are " B. P." That book is revised every ten years to discard the old drugs which have proved useless and to add new ones which are found to be useful.

Composition of Drugs

INORGANIC drugs are of unvarying composition and these are represented by chemical formulæ. Potassium Chlorate, from whatever source it is prepared or obtained, must always contain a definite quantity of Potassium, Chlorine and Oxygen and it is represented by the formula $KClO_3$.

Organic drugs on the other hand are very complex, and their compositions, which vary according to the climate and soil in which they grow can only be ascertained by chemical analysis. The organic drugs in their composition contain an active constituent, which is responsible for their curative and toxic actions. In addition to this, they contain many inert substances which are of no value therapeutically. The active principles of the majority of drugs are now known and in some cases their exact chemical compositions are also ascertained. The principal constituents of plants to which are assigned their therapeutic value are the following:—

Alkaloids.—Alkaloids are definite chemical bodies found in the tissues of plants and animals. A few are synthetically prepared from pyridine bases. The following are their characteristics: (1) They are active nitrogenous principles of organic bodies with a bitter taste and alkaline reaction. (2) They are compound ammonias, that is to say, one or more atoms of hydrogen in ammonia (NH_3) is replaced by various radicals. (3) A few are liquid, as Pilocarpine, Conine, Nicotine, Sparteine, Lobeline; and they nearly always contain only carbon, hydrogen and nitrogen in their composition. (4) Solid ones are colourless and contain oxygen in addition to carbon, hydrogen and nitrogen. (5) They are insoluble in water, except Codeine and Brucine; but they all dissolve in alcohol, chloroform and oils. (6) They combine with acids to form soluble salts without the production of water. (7) They are incompatible with alkalies.

As regards their nomenclature they terminate in Latin in " ina " and in English " ine "; as Atropina (Latin), Atropine (English).

The Official alkaloids are Atropine, Caffeine, Cocaine, Codeine, while only the salts of the following alkaloids are official:—Emetine, Morphine, Hyoscine, Pilocarpine, Pelletierine, Physostigmine, Quinine, and Strychnine.

Acids—are salts of hydrogen. Organic acids are found in plants, either in a free state or in combination with inorganic bases, such as Potassium or Calcium.

Neutral Principles.—These are indifferent proximate crystalline principles whose chemical composition is not known. From their bitter taste they are also known as *bitter principles* or *amaroids*. They are either neutral or acid in reaction. They form salts with alkalies. They differ from glucosides in not splitting into glucose and from alkaloids in not being precipitated by tannin.

Examples in the B. P., **Aloin, Santonin, Quassin,** etc.

Glucosides—or Saccharoides are crystalline bodies which when acted upon by acids, alkalies or unorganised ferments in the presence of water, decompose into two or more substances, of which one is glucose. Glucosides resemble alkaloids in having a marked selective action, but differ from them chemically, in not having the basic character nor forming salts with acids.

Just as the names of all alkaloids end in " ine " in English, those of glucosides and neutral principles end in " in."

Examples in the B. P., **Salicin, Strophanthin, Senegin,** etc.

Saponins—are a group of glucosides which are soluble in water and like soap form froth when shaken up. They may be used as emulsifying agents for oils and resins. Poisonous saponins are known as *Sapotoxins*.

Fixed Oils—are compounds of higher fatty acids which remain fluid at an ordinary temperature. They are obtained from fruits or seeds of plants, or from animal tissues, by expression or by boiling them in water and skimming off the melted oil. The fatty acids contained in their composition are Oleic (liquid), Palmitic (semi-solid) and Stearic (solid). They form soap and glycerine when acted upon by caustic alkalies or metallic oxides. This process is called *saponification*. They are usually straw-coloured, and they cause a greasy mark on paper. Though insoluble in water they are freely soluble in ether, chloroform, benzol, and turpentine. Castor oil is soluble in alcohol. When heated, they decompose and become rancid.

Examples in the B. P., **Olea, Amygdalæ, Arachis, Gossypii Seminis Lini, Olivæ, Ricini,** etc. **Oleum Morrhuæ** is of animal origin.

Fats—are fixed oils, which are solid at ordinary temperature, owing to the excess of Stearin and Palmitin in their composition.

Examples in the B. P., **Oleum Theobromatis, Adeps, Adeps Lanæ Sevum,** etc.

Waxes—are fats having a higher melting point and a firmer consistence. They cannot be saponified by boiling with an alkali.

Volatile Oils—are complex mixtures of aldehydes, phenol derivatives, ethereal salts or esters, alcohols and ketones with turpenes of varying compositions. They are obtained by distillation of entire plants, flowers, fruits or seeds. *Oleum Limonis* is an exception, though a volatile oil, it is obtained by expression. They resemble fixed oils in their solubility in ether and chloroform and in being lighter than water, except the volatile oils of *clove and cinnamom* which sink in water. They differ from fixed oils in that (1) their mode of preparation which is by distillation; (2) they do not leave a greasy mark on paper; (3) they are sufficiently soluble in water so as to impart their taste and odour to it; (4) they do not form soap with alkalies; (5) they do not become rancid, but tend to resinify on being exposed to light and air. They are often spoken of as *Essential Oils*.

Examples in the B. P., **Olea Anethi, Cinnamomi, Cajuputi, Lavandulæ** and others.

Stearoptenes—are crystalline oxidised hydrocarbons or solid volatile oils.

Examples in the B. P., **Camphor, Menthol,** and **Thymol.**

Resins—are solid, brittle, non-volatile complex bodies derived by oxidation of turpenes or volatile oils. They are insoluble in water, but soluble in alcohol and in alkalies forming resin soaps.

Examples in the B. P., **Colophony** and **Resina Podophylli.**

Oleo-Resins—are natural products of resin and volatile oil.

Examples in the B. P., **Copaiba.**

Balsams—are combinations of resins or oleo-resins with benzoic or cinnamic acid or both.

Examples in the B. P. **Benzoin, Balsams of Peru, Tolu** and **Storax.**

Gums—are amorphous carbohydrates obtained by exudations from the stems and branches of plants. With water, they form a colloidal solution in which the minute particles remain amphoral and diffuse with difficulty ; they are, however, precipitated by alcohol. They are composed of :

(*a*) Arabin or soluble gum, *e.g.*, Acacia.

(*b*) Bassorin or partially soluble gum which swells in water to form a jelly-like mass, *e.g.*, Tragacanth.

(*c*) Cerasin or insoluble gum.

Gum-Resins—are exudations from plants consisting of a mixture of gums and oleo-resins. They form an emulsion when rubbed with water, the solution of gum in them forming a viscid material to keep the resinous and oily particles in suspension.

Examples in the B. P., **Asafetida** and **Myrrh.**

Official Preparations of Crude Drugs

MOST of the drugs in their crude and unprepared form are not fit for internal administration. They are either too nauseous or too bulky or they contain poisonous elements. They have, therefore, to undergo a series of manipulations before they are in a condition suitable for administration. By extracting out of these crude drugs their active constituents by suitable solvents, preparations for administration can be made according to the instructions given in the pharmacopœas of different countries. The principal solvents used for such preparations are water, alcohol of different strengths, olive oil, glycerine and others. For reasons of portability and keeping qualities, the solvents in some cases are evaporated till the residue reaches the consistency of a semi-solid or solid. The following are the official preparations of the B. P. 1932 :—

Aceta.—Vinegars are solutions of the active principles of the drugs extracted by maceration or digestion with dilute acetic acid and not with Vinegar. B. P. contains only one :—

Acetum Scillæ—Dose – 10 to 30 ms.—0·6 to 2 mils.

Aquæ—are waters which are plain, aromatic, and concentrated aromatic.

Plain waters are obtained by distillation :—

Aqua Distillata ; Aqua Sterilisata.

Aromatic waters are weak solutions of volatile substances in water. They are obtained by :—

1. Distilling the drug with water ;

   Aqua Anethi Distillata ;
   Aqua Cinnamomi Distillata.

2. Distilling the essential oil with water ;

   Aqua Menthæ Piperitæ Distillata.

3. Repeatedly shaking an essential oil with five hundred times its volume of distilled water and setting the mixture aside for twelve hours or more.

Alternatively, triturating the volatile oil with a sufficient quantity of powdered talc, or kieselguhr or of pulped filter paper and five hundred times its volume of distilled water and filtering.

4. Simply dissolving a substance in cold water:
Aqua Camphoræ and **Chloroformi.**

5. Diluting the concentrated water with 39 times its volume of distilled water.

Dosage—All fresh aromatic waters have a dose of ½ to 1 fl. oz.—15 to 30 mils.

Concentrated aromatic waters are strong solutions of Volatile substance in alcohol and water. They are prepared by dissolving two parts of essential oil in sufficient quantity of alcohol and adding successive small quantities of distilled water to produce 100. The B. P. contains only three :—

Aqua Anethi Concentrata; Aqua Cinnamomi Concentrata and **Aqua Menthæ Piperitæ Concentrata.**

Dosage—All concentrated waters have a dose of 5 to 15 ms.—0·3 to 1 mil.

Cataplasmata.—Cataplasms or poultices are soft masses to supply moisture and warmth locally in order to stimulate local protective reaction in inflamed tissues, or to act as counter-irritants. Linseed meal, bran, bread and milk, kaolin and glycerine answer well for these, to which either tincture of opium, aconite or any other anodyne may be added to lessen pain. Poultice should be prepared by boiling the moistened mass, enclosing it in a bag of cloth of the required size and by applying about ½ or 1 inch thick over inflamed area. The addition of a little fixed oil or glycerine serves to retain heat and prevent cracking. A covering of oiled silk retains heat much longer. The B. P. contains only one :—

Cataplasma Kaolini.

Collodia.—Collodions are solutions of pyroxilin in ether and alcohol. When applied to the skin, the solvent evaporates, leaving a protective film of pyroxilin. The B. P. contains only one :—

Collodiun Flexile.

Confectiones.—Confections are preparations of powdered drugs made into a paste with sugar or honey, either to give them an agreeable taste or to preserve them. The B. P. contains only two :—

Confectio Sennæ ; Confectio Sulphuris.

Dosage—All have a dose of 60 to 120 grs.—4 to 8 G.

Elixira.—Elixirs are sweet, aromatic, hydro-alcoholic medicated liquids. Their alcoholic strength is generally about 12 to 20 per cent. The B. P. contains only one :—

Elixir Cascaræ Sagradæ.

Dose—30 to 60 ms.—2 to 4 mils.

Emplastra.—Plasters are external applications, spread on leather, linen or silk ; they become soft and adherent to the skin at the temperature of the body. These are in the form of rolls which are heated enough to be spread evenly with a heated spatula. All plasters contain lead except *Emplastrum cantharidini*. The B. P. contains only four :—

Emplastrum Belladonnæ ; Emplastrum Colophoni ;
„ Cantharidini ; „ Plumbi.

Emulsiones.—Emulsions are aqueous, milk-like mixtures of oils, fats or resin in a minutely subdivided state, suspended by mucilagenous materials. B. P. contains four :—

Emulsio Chloroformi, Emulsio Menthæ Piperitæ.

Dosage—5 to 30 ms.

Emulsio Olei Morrhuæ ; Emulsio Olei Vitaminati.

Dosage—90 to 180 ms ; 30 to 60 ms.

Extracta.—Extracts are concentrated preparations made by evaporating solutions of the medicinal principles of drugs of the animal or vegetable kingdom, to a desired consistency. They are classified, according to their consistency as solid and liquid extracts. Solid Extracts are further classified, according to the evaporation of the solvent used as aqueous, alcoholic and ethereal. The word "*siccum,*" used, after some extracts, generally denotes that a liquid extract of the same drug is official in the B. P. except in the case of the dry extracts of Krameria and Opium which have no corresponding liquid extracts. B. P. contains in all 30 extracts of which only three are from the animal kingdom.

In tropical and sub-tropical parts of the Empire, if any liquid extract is found to contain less than 30 per cent. of ethyl alcohol, it is permissible to increase the same to 30 per cent. to prevent fermentation.

Dosage—The doses of extracts are irregular owing to the varying strength of the active constituents of drugs. They are classified below according to their doses and consistency :—

SOLID EXTRACTS (14)

	Dose :		*Dose :*
Ext. Belladonnæ Sicc. „ **Colchici** „ „ **Hyoscyami** „ „ **Nucis Vomicæ** „ „ **Opii** „ „ **Stramonii** „	¼ to 1 gr. 0·015 to 0·06 G.	**Ext. Fellis Bovini** „ **Krameriæ Sicc.**	5 to 15 grs. 0·3 to 1 G.
„ **Cascaræ Sagradæ Sicc.** „ **Cinchonæ** „ **Colocynthidis Co.** „ **Gentianæ**	2 to 8 grs. 0·12 to 0·5 G.	„ **Glycyrrhizæ**	10 to 30 grs. 0·6 to 2 G.
		„ **Hepatis Sicc.**	**Contents of one tube.**

LIQUID EXTRACTS (20)

	Dose :		*Dose :*
Ext. Belladonnæ Liq.	¼ to 1 m. 0·015 to 0·06 mil.	**Ext. Sennæ Liq.**	10 to 30 ms. 0·6 to 2 mils.
,, **Ipecacuanhæ Liq.**	½ to 2ms. 0·03 to 0·12 mil. 10 to 30 ms. 0·6 to 2 mils. emetic.	,, **Cascaræ Sagradæ Liq.** ,, **Glycyrrhizæ Liq.** ,, **Hamamelidis Liq.**	30 to 60 ms. 2 to 4 mils.
,, **Nucis Vomicæ Liq.** ,, **Stramonii Liq.**	1 to 3 ms 0·06 to 0·2 mil.	,, **Fillicis Liq.**	45 to 90 ms. 3 to 6 mils.
,, **Quillaiæ Liq.**	1½ to 3 ms. 0·1 to 0·2 mil.	,, **Malti Liq.** **c Ol. Morrhuæ** ,, **Malti**	60 to 240 ms. 4 to 16 mils.
,, **Scillæ Liq.**	1½ to 3ms. 0·1 to 0·2 mil.		
,, **Colchici Liq.**	2 to 5ms. 0.12 to 0 3 mil.	,, **Hepatis Liq.**	1 fl. oz. 30 mils.
,, **Hyoscyami Liq.**	3 to 6ms 0·2 to 0·4 mils.	,, **Pituitary Liq.**	2 to 5 units 0·2 to 0·5mils. subcutaneously.
,, **Cinchonæ Liq.** ,, **Senegæ Liq.**	5 to 15ms. 0·3 to 1 mil.		
,, **Ergotæ Liq.**	10 to 20 ms. 0.6 to 1·2 mils.		

Glycerina.—These are solutions of drugs in glycerine or glycerine and distilled water. They are mostly liquid preparations except *glycerine of starch* which is semi-solid. They are intended for local application. Glycerine of phenol may be given internally in doses of 5 to 15 ms. The B. P. contains six of them :—

Glycerinum Amyli ;
Glycerinum Acidi Borici ;
Glycerinum Aluminis ;
Glycerinum Phenolis ;
Glycerinum Boracis ;
Glycerinum Acidi Tannici.

Infusa.—Infusions are either fresh or concentrated. They are solutions of vegetable principles, obtained by soaking coarsely powdered or bruised drug in hot or cold water. They may be prepared afresh or by diluting concentrated infusions with seven times their volume of distilled water. Infusions prepared by dilution are approximately equivalent in strength, but not in flavour, to fresh infusions; and they differ also in containing a small proportion of alcohol. *Infusum Digitalis* is always to be prepared fresh as the use of a concentrated infusion of digitalis is not sanctioned.

Infusions of Calumba and Quassia are made with cold water to prevent the solution of starch which Calumba contains and to prevent the excess of solution of the bitter principle which Quassia contains.

All Infusions except *Infusions Quassia and Calumba* become inky with iron salts owing to the presence of tannin of the drugs in the solution.

The following are the fresh and concentrated infusions in the B. P. :—

Infusum Aurantii Recens
„ „ Concentratum
„ Buchu Recens
„ „ Concentratum
„ Calumbæ Recens
„ „ Concentratum
„ Caryophylli Recens
„ „ Concentratum
Infusum Gentiani Compositum Recens
„ „ „ Concentratum
„ Quassiæ Recens
„ „ Concentratum
„ Senegæ Recens
„ „ Concentratum
„ Sennæ Recens
„ „ Concentratum

Infusum Digitalis Recens.

Dosage—All fresh infusions have a dose of ½ to 1 or

2 fl. ozs., except Infusion Digitalis, the dose of which is 1 to 4 fl. ozs. All concentrated infusions have a dose of 30 to 60 ms.

Injectiones.—Injections are sterile solutions of drugs, organic or inorganic, for injecting under the skin, into the muscle, or into the vein. They are dispensed in successive doses in a sealed container so as to exclude bacteria. If the solution consists of a stock from which successive doses are withdrawn on different occasions, it contains a suitable antiseptic in such concentration as will prevent the growth of bacteria. The B. P. contains fourteen :—

Injectio Bismuthi
„ Ferri
„ Hydrargyri Subchloridi
„ Bismuth Oxychloridi
„ Mersalyli
„ Sodii Morhuatis
„ Calii Gluconatis

Injectio Bismuthi Salicylatis
„ Hydrargyri
„ Lepatazoli
„ Quininæ et Urethani
„ Procainæ et Adrenalinœ
„ Nikethamidi
„ Sodii Chloridi et Acacæ

Dosage—Their doses vary from 5 to 30 ms.—0·3 to 2 mils., except the last, which has no dose.

Lamellæ.—Eye discs are thin circular discs about 1/8 of an inch in diameter made by incorporating a fractional quantity of an alkaloidal salt in Glycerine and Gelatin. They are used for dropping into the eye. B. P. contains only four lamellæ :—

Lamellæ Atropinæ
(1/5000 gr.)
„ Cocainae
(1/50 gr.)

Lamellæ Homatropinæ
(1/100 gr.)
„ Physostigminæ
(1/1000 gr.)

Linimenta.—Liniments or embrocations are oily spirituous or soapy applications to the skin and are generally administered by friction with the hand. Liniment of Aconite on account of its toxicity is simply painted on the skin. All liniments contain camphor in their composition. The B. P. contains seven :—

Linimentum Aconiti
„ **Belladonnæ**
„ **Camphoræ**
„ „ **Ammoniatum**
Linimentum Saponis
„ **Terebinthinæ**
„ „ **Aceticum**

Liquores.—Liquors are solutions of definite chemical substances in water, alcohol or other fluids. The B. P. contains in all 34 liquors of which those marked with an asterisk are not given internally :—

Liquor Adrenalinæ Hydrochloridi
„ **Ammoniæ Dilutus**
„ „ **Fortis***
„ **Ammonii Acetatis Dilutus**
„ „ „ **Fortis**
„ **Ammoniæ Aromaticus**
„ **Arsenicalis**
„ **Arseni et Hydrargyri Iodidi**
„ **Æthylis Nitritis Concentratus**
„ **Calcii Hydroxidi**
„ **Calciferolis**
„ **Cresolis Saponatus***
„ **Epispasticus***
„ **Ferri Perchloridi.**
„ **Formaldehydi***
„ **Glycerylis Trinitratis**
„ **Hydrargyri Perchloridi**
„ **Hydrogenii Peroxidi**
Liquor Iodi Aquosus
„ **Iodi Fortis***
„ **Iodi Mitis**
„ **Iodi Simplex**
„ **Magnesii Bicarbonatis**
„ **Morphinæ Hydrochloridi**
„ **Picis Carbonis***
„ **Plumbi Subacetatis Dilutus***
„ „ „ **Fortis** *
„ **Potassii Hydroxidi**
„ **Quininæ Ammoniatus**
„ **Sodæ Chlorinatæ Chirurgicalis***
„ **Sodii Chloridi Physiologicus***
„ **Strychninæ Hydrochloridi**
„ **Vitamini A Concentratus**
„ **Vitamini D** „
„ **Vitaminorum A et D** „

Dosage—Doses of liquors and their strengths are variable. *Liq. Adrenalini Hydrochloridi* is administered subcutaneously.

Lotiones.—Lotions are medicinal solutions for external use. They are applied locally on linen, lint or muslin. They are also used for washing out wounds and ulcers. The B. P. contains only one :—

Lotio Hydrargyri Nigra.

Mella.—Honeys are liquid preparations containing honey as a vehicle. The B. P. contains only two :—

Mel Boracis ; Mel Depuratum.

Misturæ.—Mixtures are preparations containing drugs dissolved in water or suspended in it. The B. P. contains only two :—

Mistura Magnesii Hydroxidi ;	**Mistura Sennæ Composita :**
Dose—60 to 240 ms. 4 to 16 mils.	**Dose**—1 to 2 fl. ozs. 30 to 60 mils.

Mucilagines.—Mucilages are watery solutions containing gums. Official mucilages are prepared with chloroform water to avoid fermentation. The B. P. contains two :—

Mucilago Acacæ ; Mucilago Tragacanthæ.

Dosage—60 to 240 ms.—4 to 16 mils.

Oculenta.—Ointments for the eye are prepared by triturating a definite percentage of drugs in a basis made up by melting, filtering, and sterilising 90 parts of yellow soft paraffin and 10 parts of wool fat. They should be kept in small, well closed, containers protected from light and stored in a cool place. The B. P. contains seven :—

Oculentum Atropinæ : Atropine sulphate 0·25 per cent.
Oculentum Atropinæ cum Hydrargyri Oxido : Atropine sulphate 0·125 per cent.; yellow mercuric oxide 1 per cent.
Oculentum Cocainæ : Cocaine Hydrochloride 0·25 per cent.
Oculentum Hydrargyri Oxidi : Yellow mercuric oxide 1 per cent.
Oculentum Hyoscinæ : Hyoscine Hydrobromide 0·125 per cent.
Oculentum Iodoformi : Iodoform 4 per cent.
Oculentum Physostigminæ : Physostigmine Salicylate 0·125 per cent.

Olea.—Oils are either fixed or volatile. Fixed oils are obtained by expression. Volatile oils are obtained by distillation, except *Oil of Lemon*, which is obtained by expression. They are all liquid except *Oil of Theobroma*, which is solid in cold weather.

FIXED OILS

Oleum Amygdalæ
„ Arachis
„ Gossypii Seminis
„ Hippoglossi
„ Hydnocarpi
„ Hydnocarpi Æthylicum
„ Iodisalum
Oleum Lini
„ Morrhuæ
„ Olivæ
„ Ricini
„ Sesami
„ Theobromatis
„ Vitaminatum

Dosage—Nearly all fixed Oils have a dose of ½ to 1 fl. oz., 15 to 30 mils: except *Castor Oil*, Dose—60 to 240 ms.—4 to 16 mils; *Cod-liver Oil*, Dose—30 to 120 ms.—2 to 8 mils; *Hydnocarpus Oil*, Dose—5 to 15 ms.—0·3 to 1 mil. gradually increased to 60 ms.—4 mils.

VOLATILE OILS

Oleum Abietis
„ Amygdlæ
„ Anethi
„ Anisi
„ Cadinum
„ Cajuputi
„ Cari
„ Caryophylli
„ Chenopodii
Oleum Cinnamomi
„ Coriandri
„ Eucalypti
„ Lavandulæ
„ Lemonis
„ Menthi Piperitæ
„ Myristicæ
„ Terebinthinæ

Dosage—Most of the volatile oils have a dose of 1 to 3 ms.—0·06 to 0·2 mil., except *Oil of Chenopodium*, Dose—3 to 15 ms.—0·2 to 1 mil.; *Oil of Sandal Wood*, Dose—5 to 15 ms.—0·3 to 1 mil.; and *Oil of Turpentine*, Dose—3 to 10 ms.—0·2 to 0·6 mil.; 20 to 240 ms.—8 to 16 mils. as anthelmintic.

Oil of Siberian Fir is used for inhalation purposes. *Oil of Cade* is used externally, and *Oil of Theobroma* is used for making suppositories; hence these oils have no dose assigned to them.

Oxymella.—Oxymels are preparations containing honey and acetic acid. The B. P. contains only two:—

Oxymel:	**Oxymel Scillæ.**
Dose—30 to 120 ms. 2 to 8 mils.	**Dose**—30 to 60 ms. 2 to 4 mils.

Pilulæ.—Pills are solid spherical masses of medicine held together by some adhesive substance. They are intended to be swallowed as a whole without chewing. Almost all the official pills, except pill of Iron Carbonate, have a purgative effect. The B. P. contains seven :—

Pilula Aloes
,, ,, et Asafœtidæ
,, ,, ,, Ferri
,, Colocynthidis et Hyoscyami
Pilula Ferri Carbonatis
,, Hydrargyri
,, Rhei Composita

Dosage—All pills are given in doses of 4 to 8 grs.—0·25 to 0·5 G. except *Pilula Ferri Carbonatis.* Dose—5 to 30 grs.—0·3 to 2 G.

Pulveres.—Powders are compounds of dry insoluble drugs reduced to powder and intimately mixed together. The B. P. contains eight :—

Pulvis Cretæ Aromaticus
,, ,, ,, cum Opio
,, Effervescens Compositus
,, Glycyrrhizæ ,,
,, Ipecacuanhæ et Opii
Pulvis Jalapae Compositus
,, Rhei Compositus
,, Tragacanthæ Compositus
,, Vitamini B1

Dosage—The majority of the powders have a dose of 10 to 60 grs.—0·6 to 4 G. except :

Pulvis Effervescens Compositus, Dose—not specific.
,, Glycyrrhizæ Compositus, Dose—60 to 120 grs.—4 to 8 G.
,, Ipecacuanhæ et Opii, Dose—5 to 10 grs.—0·3 to 0·6 G.

Spiritus.—Spirits are either simple or complex. Their total number in the B. P. is eight.

Simple Spirits are alcoholic Solutions of Volatile substances :—

Spiritus Cajuputi
,, Camphoræ
,, Chloroformi
Spiritus Cinnamomi
,, Ætheris
,, Menthæ Piperitæ

Complex Spirits are of varying composition and are prepared by distillation.

Spiritus, Ætheris Nitrosi and **Ammoniæ Aromaticus.**

Spiritus Methylatus Industrialis.—Industrial methylated spirit is a mixture of 1 volume of approved wood naphtha and 19 volumes of alcohol (95 per cent.) and it is of the quality known as "66 O. P." It is not given internally.

Dosage—Simple spirits have a dose of 5 to 30 ms.—0·3 to 2 mils. except Spirit Etheris; Dose—15 to 60 ms.—1 to 4 mils. Complex spirits have a dose of 15 to 60 ms.—1 to 4 mils.

Suppositoria.—Suppositories are solid conical masses made by blending some active ingredient with a fatty or gelatinous basis, for introducing into the rectum or vagina. A suppository approximately weighs 15 grs. The fatty basis used in the preparation of suppositories is generally Oleum Theobroma, except in the case of Glycerine Suppositories, which have gelatin as the basis and are made to weigh 30 to 120 grs. In hot regions the melting point of Oil of Theobroma may be raised by the addition of white beeswax. The B. P. contains seven :—

Suppositoria Acidi Tannici, Belladonnæ, Iodoformi, Morphinæ Phenolis, Plumbi cum Opio and Glycerini.

Syrupi.—Syrups are fluid preparations of drugs containing a large quantity of sugar, either to preserve them or to make their administration more agreeable. The B. P. contains twelve :—

Syrupus Aurantii
" Ferri Iodidi
" " Phosphatis Compositus
" " Cum Quinina et Strychnina

Syrupus Glucosi Liquidi
" Limonis
" Pruni Serotinæ
" Scillæ
" Sennæ
" Tolutanus
" Zingiberis.

Dosage—Dose of syrups is 30 to 120 ms.—2 to 8 mils. except Syrupus Ferri Phosphatis cum Quinina et Strychnina and Syrupus Scillæ, doses of which are 30 to 60 ms.—2 to 4 mils.

Tabellæ.—Tablets are small flat pieces of chocolate containing a minute quantity of medicinal agents. The B. P. contains only one :—

Tabella Glycerylis Trinitratis.

Dose—1 to 2 tablets.

Tincturæ.—Tinctures are solutions of active ingredients of drugs in alcohol. These are divided into "Simple" and "Compound." Simple tinctures contain one ingredient and one solvent, while compound tinctures contain several ingredients in one solvent. Some tinctures contain more than one ingredient in their composition, yet the same is not expressed in their names. They may be called "complex." These are prepared by maceration, percolation or by simple solution of ingredients.

1. *Maceration* is the process of soaking a drug for about seven days in alcohol or some similar menstruum in a closed vessel, which is occasionally shaken in order to dissolve the soluble matter of the drug. It is then strained. The insoluble matter or "marc" is pressed and the strained and pressed liquids are mixed together to form a tincture.

2. *Percolation* is the process of extracting the soluble matter of a drug by the filtration of a liquid menstruum through a porous column of powder, previously moistened with a sufficient quantity of the same menstruum and packed in a special conical vessel, called the percolater. The drug is allowed to macerate for 24 hours. The percolated fluid is then mixed with the fluid obtained by pressing the marc and is clarified by subsidence or by filtration.

3. *Simple solutions* of liquid or soft extracts of drugs

in alcohols of various strengths. The majority of tinctures of poisonous drugs are made by this process:—

Tinctures differ from spirits in asmuch as they contain non-volatile ingredients.

Dosage—The majority of the tinctures of non-poisonous drugs and all compound and ammoniated tinctures have a dose of 30 to 60 ms.—2 to 4 mils. A few of the non-poisonous drugs and of all poisonous drugs have a dose of 5 to 15 or 30 ms.—0·3 to 1 mil. They are arranged below according to the gradation of doses. The B. P. contains thirty-four :

Tinct. Strophanthi	2 to 5 ms. 0·12 to 0·3 mil.
„ **Zingiberis Fort.**	5 to 10 ms. 0·3 to 0·6 mil.
„ **Capsici**	5 to 15 ms. 0·3 to 1 mil.
„ **Cocci**	
„ **Colchici**	
„ **Digitalis**	
„ **Lobelia Ætherea**	
„ **Belladonnæ**	5 to 30 ms. 0·3 to 2 mils.
„ **Opii**	
„ **Scillæ**	
„ **Stramonii**	
„ **Ipecacuanhæ**	10 to 30 ms. 0·6 to 2 mils.
„ **Nucis Vomicæ**	
Tinct. Asafetidæ	30 to 60 ms. 2 to 4 mils.
„ **Aurantii**	
„ **Benzoin Co.**	
„ **Calumbæ**	
„ **Cardamomi Co.**	
„ **Catechu**	
„ **Cinchonæ**	
„ **Cinchonæ Co.**	
„ **Gentianæ Co.**	
„ **Hyoscyami**	
„ **Krameriæ**	
„ **Limonis**	
„ **Myrrhæ**	
„ **Opii Camphorata**	
„ **Quassiæ**	
„ **Quillaiæ**	
„ **Rhei Co.**	
„ **Senegæ**	
„ **Tolutana**	
„ **Valerianæ Ammoniata**	
„ **Zingiberis mitis**	

Tincturæ Concentratæ.—The following concentrated tinctures have four times the strength of the corresponding tinctures, except concentrated Tincture Opii Camphorata which has eight times the strength of the corresponding tinctures.

Tinct. Aurantii Concentrata
„ Capsici Concentrata
„ Cardamomi Composita Concentrata
„ Cinchonæ Composita Concentrata
„ Gentianæ Composita Concentrata
„ Limonis Concentrata
Tinct. Lobeliæ Ætherea Concentrata
„ Opii Camphorata Concentrata
„ Quassiæ Concentrata
„ Tolutana Concentrata
„ Valerianæ Ammoniata Concentrata

Dosage—The majority of concentrated Tinctura have a dose of 8 to 15 minims. Concentrated Tinctures of Capsici and Lobeliæ Ætherea have a dose of 1 to 4 minims and concentrated Tincture of Opii Camphorata has a dose of 4 to 8 minims.

Trochisci.—Lozenges or troches are flat solid preparations made by incorporating the drug in a basis made up by mixing sugar, mucilage acacia and tincture of tolu. They are meant to be sucked in the mouth. The B. P. contains six:

Trochiscus Acidi Tannici
„ Bismuthi Co.
„ Krameriæ
Trochiscus Krameriæ et Cocainæ.
„ Morphinæ et Ipecacuanha
„ Phenolis

Unguenta.—Ointments are soft or semi-solid preparations for external use, liquefying when rubbed on the skin, and containing medicine in a basis of lard, benzoated lard, olive oil, wax, paraffin or hydrous wool fat. The B. P. contains twenty-one, of which eight are mercurial:—

Mercurial Ointments:

Unguentum Hydrargyri
„ „ Dilutum
„ „ Ammoniati
„ „ Compositum
„ „ Nitratis Dilutum
Unguentum Hydrargyri Nitratis Forte
„ „ Oleati
„ „ Subchloridi

Non-mercurial Ointments :

Unguentum Acid Borici
,, ,, Salicylici
,, ,, Tannici
,, Aquosum
,, Capsici
,, Chrysarobini
,, Hamamelidis

Unguentum Paraffini
,, Phenolis
,, Simplex
,, Sulphuris
,, Zinci Oleatis
,, Zinci Oxidi

Besides these official preparations, the following non-official preparations are also used :—

Bougies.—Pencils are small solid cylinders of gelatin, glyco-gelatin or cacao-butter impregnated with medicine, for introducing into the ear, nose or urethra.

Cachets.—Wafers are made up of two concave discs of wafer paper, which are moistened at the edges to stick together by pressing. The cavity thus formed holds a noxious or insoluble drug and it is swallowed as a whole. Cachet should be dipped in water before swallowing.

Capsules.—Casings are short tubes, usually with one open end fitting over that of another, of gelatin, hard or soft, for administering nauseous or disagreeable liquids or solids.

Collunaria.—Nasal douches are lotions used for washing or irrigating the nasal cavities.

Collyria.—Eye-washes are liquid applications for the eyes, composed generally of some astringent salt dissolved in rose water.

Cremora.—Creams are preparations having glycerine, vaseline or other oily basis and are used for external application or injection.

Enemata.—Enemas or clysters are liquids given per rectum, either in a large quantity to act mechanically in emptying the bowel, or in a small quantity to act as medicine or nutrient.

Fomenta.—Fomentations consist of flannel wrung out of hot water and applied with or without medication.

Gargarisma.—Gargles are aqueous medicinal liquids for gargling the throat.

s or Vapores.—Inhalations are vapours of volatile liquids breathed in ordinary inhalation, to act locally upon the respiratory mucous membrane.

Insufflationes.—Insufflations are fine powders for blowing into nares, larynx, throat, etc.

Lincti.—Thick syrupy substances meant to be licked or swallowed slowly.

Nebulæ.—Sprays are aqueous medicinal solutions sprayed into the throat by means of an atomizer.

Pessi.—Pessaries are solid preparations meant to be introduced into the vagina.

Pigmenta.—Paints are preparations for application on the skin or mucous membrane.

Vina.—Wines are prepared by macerating a drug in sherry or orange wine. They are weak tinctures.

Administration of Drugs

DRUGS are administered to get them absorbed into the system. The absorbability of drugs depends upon their preparation and the channel through which they are introduced into the system. Solid preparations of drugs, such as pills or powders, take a longer time to absorb than aqueous or alcoholic preparations. A drug when introduced into the system by an injection is absorbed more quickly than when it is given otherwise. The action of a drug also varies considerably according to the mode of introduction into the body. Adrenaline given by the mouth, produces local action on the stomach, but when introduced by means of an injection, it causes enormous rise in blood pressure. Besides, the more rapidly a drug gets into the circulation, the more powerful is its action, the less is its destruction in the body and more sustained is its action.

The following are the various ways employed for introducing a drug into the system :—

By the Gastro-Intestinal Tract.—It is the commonest and most convenient method of administration of drugs. It is the obvious method to be made use of when a local action on the alimentary tract is desired. The rate of absorption of a drug varies in different portions of the digestive tract.

With the exception of alcohol or alcoholic preparations, very few drugs are absorbed from the stomach. Absorption chiefly occurs from the small intestines and there it occurs in all degrees. The rate of absorption is slow in the colon but it increases in the rectum. The drawback of this method of administration is that the drug may be chemically altered in the alimentary canal or it may interfere with digestion. The drugs absorbed from the intestinal canal have to pass through the liver before reaching the general circulation, and in this passage they may become medicinally very much changed, modified or even destroyed; again, some drugs never reach the circulation, for they are absorbed and immediately excreted into the intestines along with the bile.

By the Rectum.—Owing to the rectal mucous membrane having very nearly the same rate of absorption as the small intestines, drugs may be given by the rectum, either for local action on the bowel or for absorption into the system. Though the rate of absorption is slow by this method than by the stomach, yet salts of atropine and morphine in solution enter the circulation just as quickly, while those of strychnine more quickly than even by mouth. A drug is introduced into the rectum in the form of an enema or a suppository.

By the Skin.—The following are the methods used to introduce medicaments into the body through the cutaneous surface.

1. *Epidermic.*—Here, medicines incorporated in fatty basis are rubbed with friction directly on the skin, thus promoting their passage through and between epidermal cells, either to have a local or systemic effect. The parts of the body chosen for rubbing are those where the skin is thinnest (axillæ, groins, abdomen, inner side of the thighs). This method is also called **inunction**.

2. *Enepidermic.*—In this method to have a purely local effect, the drugs are applied to the skin without

friction. Pastes, plasters, lotions, caustics, fomentations, ointments and blisters are thus used.

3. *Endermic.*—In this method, first a blister is produced on the skin by application of a strong solution of ammonia or blistering liquid and when the blister is raised the cuticle over it is removed to expose the raw surface and over this the drug is sprinkled in a finely powdered form to get absorbed in the body. At present, this method is little employed.

Cataphoresis.—Ionic Medication or Electric Osmosis. This method is a modification of the endermic method. In this method electricity is used to introduce a drug into the subcutaneous tissue for a more active and concentrated effect than is otherwise possible. A soluble salt is split up into its component molecules or ions by a constant electric current. A current along the positive pole drives metallic ions away from it while a current along the negative pole drives away the acid radical. A pad soaked into the solution of the drug is placed in contact with the affected part. If the action of the metal in the solution is desired, the positive pole is attached to the pad, the negative pole remaining in contact with the neutral part of the skin near by. The exactly opposite method is employed when acid radicals are to be driven into the tissues. This method affects only the tissues between the poles, and consists of producing osmosis of a drug through the skin or mucous membrane from one point to another by galvanic current. Most of the iodides, salicylates, perchloride of mercury, arsenic, cocaine, etc., are introduced into the system this way.

By Injections.—This is done by means of a syringe to which a hollow needle is attached. The following are the routes chosen for introducing a drug into the body for its systemic effects :—

Hypodermic or Subcutaneous.—This consists in injecting medicinal solutions into the subcutaneous areolar tissue with a syringe. It is the choice method when rapid absorption and quick action is desired. The absorption by this method is by the lymphatics and capillary vessels, and it has the advantage of full action of the quantity of drug used, without any possible changes from intestinal secretions. Owing to the higher concentration of the drug in the blood by this method than that of the administration by mouth, the dose necessary to produce a desired effect is small, being often about one half of the dose given by the mouth. Elimination of the drug is also quicker and the danger of cumulative action is less. The precautions for injections to be observed are, that the syringe must be sterile, and that the solutions to be injected be neutral, clear and sterile; otherwise intractable sore, sloughing, etc., might result around the puncture of the needle.

Intramuscular.—A drug which is likely to cause much pain if injected under the skin, can be injected into the muscle, *e.g.*, Quinine. Owing to the greater vascularity of the muscles than the subcutaneous tissues, the drug is more rapidly absorbed by this than by the hypodermic method. The disadvantages of this method are the pain and swelling that occur at the site of injection and the fever which sometimes follows.

Intravenous.—By this method the drug is directly injected into a vein. This is the most perilous of all methods and is resorted to only in extreme emergencies to save life. This is a method of choice when a prompt action is required; when a large quantity of the solution of a drug is to be introduced into the system, such as the introduction of large quantities of saline solution where there is loss of blood; and when the drug is too irritant to be given either by subcutaneous or intramuscular injections. Here, the rapid introduction of the drugs into the system has the disadvantage of rapid elimination. But this disadvantage is negligible as compared with the instantaneous effects that are produced. Absolute precautions of cleanliness and purity of drugs is necessary for introducing the drug into the system by this method.

Into Serous Cavities.—This method is rarely used except when the object is to wash out the serous cavity with saline solution or to produce adhesive inflammation, as injection of an irritant into the tunica vaginalis.

Intra-Cerebral, Subdural and Intra-Spinal—injections of drugs are made in the treatment of cerebro-spinal meningitis, tetanus and for producing spinal anæsthesia.

By the Mucous Surfaces.—A drug for its local action on the eye may be introduced into the conjunctiva by means of lamellæ, in the ear by means of drops, into the bladder and urethra by means of bougies and injections, in the vagina and uterus by douches, injections, medicated pessaries and cotton.

By the Lungs.—Vapours of volatile liquids or solids are inhaled with air, thereby bringing the system quickly under the influence of the drug. This quick action is due to the rapid absorption from the extensive surface of the lungs to which it is applied and to the fact that these substances penetrate the tissues more readily. Anæsthetics act by this method.

Conditions Influencing Dosage

When we speak of the dose of medicine, we mean that quantity which when administered to a patient would produce physiological actions either at once or after a series of repetitions. The British Pharmacopœia mentions minimum and maximum doses of drugs, which give the limit of range, wherein the dose could be regulated to suit the conditions and peculiarities of the patient. If the dose be larger than the maximum prescribed by the B. P., toxic symptoms are likely to supervene and if smaller than the minimum, no physiological effects are produced. In determining a therapeutic dose, due weight must, therefore, be given to the following conditions :—

1. Age.—This forms the most important factor in determining the dose. The adult dose mentioned in the B. P. would prove too strong for a child who in size and weight, is much smaller and lighter than the adult. These two factors form a basis for estimating a suitable dose for children. Age generally bears some relation to size and weight and a rough estimate of dosage can be made on this basis. The simple rule suggested by Young for children under twelve is as follows:—Divide the age by the age *plus* 12 and the resulting quotient is the fraction of an adult dose for that particular year. Thus, for a child of two years the dose will be $2 \div (2+12) = 1/7$ of an adult dose. Though this rule is useful for all practical purposes, yet it is defective in that it assumes that at a given age all children are of the same size and weight, which is not always true. In arriving at a proper dose for children, due importance must be given to the weight of a child. Clark's rule which is based on the weight of the child gives correct estimation of the dose for children; the rule being to multiply the adult dose by the weight of the child in pounds and divide by 150, the average weight in pounds of the adult.

For ages between 12 and 16, the dose should be half to two-thirds of the adult dose; and between the ages of 17 and 20, it should be two-thirds to four-fifths. Over 60, the dose should be diminished slightly.

There are certain drugs which the children tolerate even in larger doses than are obtained by calculations based on their age and weight, *e.g.*, Arsenic, Calomel, Squill, Ipecacuanha and Belladonna; while there are a few drugs which even in smallest doses, prove toxic to children, *e.g.*, Opium and other narcotics. This intolerance is probably due to the late maturity of the nervous system upon which these drugs act.

2. Weight.—Even in the case of adults, the dose should be in proportion to the body-weight. B. P. doses are for strong healthy adults of average weight and they would prove rather too strong for thin and weak individuals. Women as a rule require smaller doses than men.

3. Habit—Is a craving for some drugs taken at first to cure certain ailments, but later indulged in to a vicious extent. It lessens the medicinal power of those drugs. The dose of such a drug should be increased to produce the desired effect, as with opium, cathartics, arsenic, etc.

4. Time of Administration.—On a full stomach, absorption of a drug is slower than on an empty one; and in some cases, the action of the drug is modified. Arsenic in a full dose would set up gastric irritation on an empty stomach, but has no such action when given immediately after food. The drugs produce the greatest result when their action coincides with the natural time of the complaint for which they are administered. Hypnotics act best when given just before the natural time of sleep. Purgatives act best when given overnight. Stomachics are best given shortly before meals.

5. Mode of Administration.—The different methods of administration, by altering the rapidity of absorption, produce quantitative differences in effects, and therefore in the dosage. Drugs are rapidly absorbed from subcutaneous tissues; therefore, a smaller dose is required for hypodermic injection than when the same drug is given by mouth, for absorption is slow from the upper part of the gastro-intestinal tract. The absorption by the rectal route is lower than by the upper part of the small intestine. The dose of the drug to be administered by the rectum ought then to be bigger than when administered by the mouth; and some of the different drugs have got their own distinguishing points, *e.g.*, Strychnine is more quickly absorbed when given by the rectum than when given by the mouth.

6. Preparation of Drugs.—The soluble preparations of drugs, particularly alcoholic, such as tinctures, require a smaller dose than the same for solid preparations which take a longer time to absorb, owing to their delayed solubility. Alkaloids, glucosides and neutral principles, in their isolated forms, will act promptly and with greater intensity than the crude drugs from which they are prepared, and are, therefore, given in minute doses.

7. Disease.—Certain diseases modify considerably the dosage of a drug as can be seen in the enormous doses of opium that are required to soothe the intensity of pain in acute inflammatory conditions. Mercury and opium are badly borne by persons suffering from inflammation of the kidney, whilst mercury is tolerated in larger doses in syphilis.

8. Mental Condition.—If a patient with a receptive condition of mind is made to fix his attention on the action of drug by suggestion, the smallest quantity of drug will be quite sufficient to produce a powerful effect. This is particularly marked in case of hypnotics or drugs which produce sleep.

9. Idiosyncrasy—Is the susceptibility of an individual to peculiar and exceptional reactions to the effects of drugs. It may be genuine or apparent. *Genuine*, or idiosyncrasy proper, cannot be accounted for by any known law. Mercury, even in small doses, causes in some persons intense salivation. Potassium Iodide in therapeutic dose causes severe symptoms of cold in the head. Other drugs which manifest these idiosyncrasies are Quinine, Belladonna, Ipecacuanha and Antipyretics of the coal-tar group. *Apparent* idiosyncrasy may be due to some defect in the composition of the drug, as that it may contain one of the rare constituents in excess, to which the untoward effects may be ascribed or a drug may have deteriorated by keeping. It could also be explained on the basis of cumulation due to defective excretion.

10. Tolerance.—Some individuals are resistent to the action of drugs. It may be inborn, or acquired by habit through repeated administration. *Natural* tolerance may be due to quicker excretion than absorption. *Acquired* tolerance may be due to the body acquiring an increased power of oxidising or excreting the drug, or the cells becoming, in some way not yet understood, more resistent to its action. One hypothesis, which has been suggested, is that an antibody is formed by habitual administration and the tolerance to arsenic is explained on this basis.

This tolerance to drugs by an individual must not be confounded with immunity which animals get by repeated injections of protein poisons and toxins. These poisons induce the tissue cells to manufacture and shed off into the body fluids, antibodies or antitoxins which neutralise or inactivate the toxins.

11. Rate of Excretion.—Drugs which are excreted slowly require always a smaller dose than the drugs which are excreted rapidly. Repeated administration of the same drug requires smaller doses than the single administration of the same.

12. Accumulation or Cumulative Action.—This modifies, to some extent, the dose of medicine. Persistent administration of certain drugs at regular intervals, suddenly produce toxic symptoms. The drug gets accumulated in the body to produce a poisonous effect, which is said to be its cumulative action. The cumulative action may be due to : (1) rapid absorption of a drug and its slow excretion. as in the case of mercury and lead ; (2) sudden arrest in the excretion of a drug due to some untoward cause, such as contracting of the renal vessels. It is markedly seen in the case of Digitalis and Strychnine ; (3) sudden solution and absorption of a sparingly soluble drug, owing to the alteration in the intestinal contents ; (4) diminished resistance of the body increasing its susceptibility to poisonous effects. The drugs which produce cumulative actions are Mercury, Lead, Arsenic, Iodides, and Digitalis.

13. Climate and Temperature.—A warm climate demands smaller doses of purgatives and larger doses of antiperiodics; alcohol in larger quantities is consumed in cold countries than in the hot ones.

Antagonism and Synergism

SEVERAL drugs are administered together with the object of getting an independent result from each. The gross result of such an administration is the simple algebraical summation of effects, either in the sense of increasing the efficiency (Synergism) or of diminishing it (Antagonism).

The term antagonism, in its strict sense, is applied to the action of drugs on the anatomical structure so as to produce contrary results. In its wide sense, it means the modification of the action of a drug by another so as to correct or prevent its disadvantageous results. Antagonism may, therefore, be (1) true, direct or anatomical, (2) apparent, indirect or physiological, and (3) chemical.

1. Anatomical antagonism is manifested by drugs acting on the same structure so as to produce opposite effects. It is well seen in the contraction and dilatation of the pupil caused by the drugs pilocarpine and atropine respectively when instilled in the eye. Pilocarpine stimulates the peripheral nerve endings in the eye-ball to contract the pupil and atropine paralyses them to dilate it.

2. Physiological antagonism, which is the most frequent form of opposition among drugs, is manifested by drugs which may act on an entirely different anatomical system or on the different portions of the same anatomical system to produce opposite effects. An example of the first kind is seen in the actions of adrenaline and nitroglycerine. Adrenaline acting on the sympathetic nerve endings in the arterial walls, constricts the blood vessels which

Nitro-glycerine acting on the musculature of the arteries relaxes it. An example of the second kind is seen in the contraction of the pupil caused by opium acting centrally on the nervous system, being opposed by atropine acting peripherally to dilate it.

3. **Chemical** antagonism between drugs consists in neutralising one another. It is called antidotism. An antidote in common speech, is a substance that will hinder or oppose the effects of poison, whether by physical, or chemical action or through biological influence. It includes counteragents and antagonists as well as incompatibilities; as for example, the neutralisation of acids by alkalies, or morphine by potassium permanganate, and the precipitation of alkaloids by tannic acid, or the combination of albumen with corrosive poison.

Complete antagonism between the drugs throughout the whole range of their activity is very rare. The classical example is found in the drugs muscarine and atropine. Partial antagonism is very common and is limited to certain portions of their actions; and it is utilised in therapeutic association of remedies for correction.

Synergism means reinforcement of the action of a drug by another. Like antagonism, it may be (1) anatomical or (2) physiological.

1. **Anatomical** synergism is seen in the stimulation of the cardiac muscle and cardio-inhibitory centre in the medulla by the combination of digitalis and adrenaline for more forcible yet more slow beating of the heart than is otherwise possible by the administration of either of these drugs alone.

2. **Physiological** synergism is seen in the complete dilatation of the pupil under the combined action of cocaine and atropine. The dilatation of the pupil by paralysing the parasympathetic fibres in the iris by atropine is further dilated by cocaine by the stimulation of the sympathetic nerve endings in the iris.

3. There is a third variety of synergism, which is largely taken advantage of for therapeutical purposes, and is called **Adjuvant** synergism. It is obtained by combining *two or more drugs having the same ultimate action to produce a greater summation of their effects than the equivalent dose of any one of them singly can produce. This may be effected* by (1) combining the different preparations of the same drug, as infusion and tincture so as to bring into action the active principles not soluble in the same vehicle; (2) or by combining the drugs which produce similar results, as seen to the grouping of purgative to produce a powerful effect or in the combination of cocaine and adrenaline to produce a powerful vaso-constrictor effect.

Incompatibility

INCOMPATIBILITY consists in prescribing together substances which are medicinally inconsistent or pharmaceutically incongruous.

Medicinal Incompatibility—is the combining in a prescription such substances as have opposite physiological actions or therapeutic effects, such as the combining of bromides and strychnine which physiologically have opposite actions, or the combining of purgatives and astringents which have opposite therapeutic effects.

Pharmaceutical Incompatibility—may be chemical or physical. *Chemical* incompatibility consists in the combination of drugs which by their interaction may (1) change the colour of the mixture, as seen in the formation of inky mixtures when ferric salts are combined with tannic acid; (2) cause the liberation of gases, as seen in the liberation of carbon dioxide through the decomposition of a carbonate or bicarbonate with an acid; (3) form explosive compounds from the admixture of oxidising agents with substances which are easily oxidisable, as in the combination of permanganate of potash with glycerine; (4) produce a new compound which may be inert or possessed of distinct properties. These instances could be multiplied, but the examples cited are such as are likely to occur in the writing of a prescription.

Physical incompatibility consists (1) in the prescribing of substances in a medium in which they are insoluble or immiscible. Insoluble powders and oils will not mix with water; or (2) in prescribing together the preparations made with different solvents. The constituents which are soluble in one medium, but not in the other, are thrown out of solution as is seen in the addition of resinous tinctures to water; or (3) in the prescribing of two solids which liquefy when triturated together, as camphor, chloral, phenols and coal-tar derivatives.

Intentional Incompatibility.—In the writing of prescriptions sometimes the incompatibility is intentional in order to obtain a new compound of higher therapeutic value. The B. P. contains many instances of this kind, *e.g.*, Pil. Ferri, Co. Lotio Nigra; and all Effervescing Salts.

Permissible Incompatibility.—Bases with weak acids are sometimes prescribed with strong acids by the interaction of which a new salt is formed which has the same therapeutic effect as that of strong acid. The combination of dilute hydrocyanic acid or salicylic acid with sodium bicarbonate is an example in point.

To avoid incompatibility in a mixture, a complete knowledge of the chemistry and solubility of drugs is essential. The following rules would greatly minimise the errors:—

1. A drug should not be ordered in combination with any of its tests or antidotes.

2. All poisonous alkaloids as far as possible should be prescribed in simple solutions and not in combination and not in too concentrated a state.

3. Substances rich in oxygen as chlorates, bichromates, permanganates, oxides of silver, should not be combined

with substances which are easily oxidisable, as sulphur, sulphides, charcoal, camphor, iodide of iron, ammonia salts, reduced iron, essential oils, etc. An admixture between any of these two classes results in an explosive combination.

4. Substances containing tannic acid form insoluble compounds with albumin, alkaloids, salts of iron, mercury and lead ; with iron, they form an inky mixture.

Absorption and Excretion of Drugs

Drugs *are given with the object of being absorbed into the blood stream for producing their specific effects. The time* taken by a drug to be absorbed into the body varies from a few seconds to many weeks. Acid hydrocyanic takes a few seconds to be absorbed and produce poisonous effects while most of the metals are absorbed slowly, with the exception of mercury and arsenic, and weeks or months elapse before they induce poisonous symptoms. The rapidity of absorption depends on the nature of the drug, the mode of administration, solubility, concentration and the area submitted for absorption and circulation. These are already mentioned and discussed. The channels of absorption of a drug are the skin, mucous surfaces, and lymphatics. Absorption through skin is restricted only to oily preparations, as the cutaneous glands are filled with fatty material to which water is impervious. Through this channel, the substances come in contact with the living protoplasm of the glands by which they are taken up in the system. When given by mouth, the drugs are principally absorbed by the mucous membrane of the upper part of the small intestine, either directly into the blood or through the lacteals. The stomach has very little absorptive power except for alcoholic preparations of drugs. It must, however, be noted that all drugs are not absorbed by the alimentary tract. It exerts its selective action for absorption and prohibits the absorption of others as seen in the selection of K and Cl ions and rejection of SO_4 and Mg ions. When the drug is injected either subcutaneously or intra-muscularly, it is taken up by the lymphatics and carried into the circulation. The drug after its sojourn in the blood, either penetrates by selection into particular tissues to produce its specific effects or is excreted out of the system by channels of excretions.

The excretion of a drug occurs mainly through the urine and partly through the fœces, sweat, saliva and other secretions of the body. With volatile drugs excretion occurs mainly through the lungs. The relative importance of these different channels of excretion varies for each drug, the reason of which is but little understood. The rapidity of excretion is proportional to the circulation and to the functional activity of the excretory organs and may be increased or decreased by factors which stimulate or depress these. There are certain drugs, however, which are partly excreted and partly retained in the body in the form of combination and their elimination is possible by substances which displace them from their combination, *e.g.*, lead accumulated into the body can be dislodged from its combination by potassium iodide. The administration of chlorides causes increased excretion of iodides.

Effects of Absorption and Excretion of Drugs.—The pharmacological action of a drug, therefore, is dependent upon its absorption and excretion and is manifested by stimulating or depressing the function of the cell. If the stimulus is strong enough to injure the tissue it is called irritation. If the stimulation is moderate and prolonged, it exhausts the cell and depresses its activity and if the stimulation is stopped, the cell gradually regains its functions, provided it is not destroyed by over-stimulation ; in such cases paralysis supervenes and functions are destroyed. There are many drugs, particularly narcotics, which when given in small doses stimulate the function of an organ but depress it when given in large doses. Drugs, thus, only interfere with the normal function of an organ and have no power to change its function. They change the activity of an organ quantitatively and not qualitatively.

Methods of Action of Drugs

I. Selective Action.—All the tissues of the body are subjected to the same concentration of a drug, when it is absorbed, since, on absorption, a drug is carried by blood and lymph to all the tissues of the body.

It is, however, found that actions of drugs are generally much greater on some tissues or organs than on others; that is, they select a tissue or organ for their action, and the drugs acting in such a way are said to have a selective action.

The possibility of a drug being used medicinally depends on this selection of an organ for its action. This fact is availed of in the modern treatment of parasitic diseases and forms the basis of chemo-therapy. The action of drugs on the central and peripheral nervous system generally belongs to this selective type. The mechanism of selective action is not known. It may possibly be due to (1) differences of penetration; (2) the chemical affinities of the cell; or (3) sensitiveness of function,—the more delicate functions being influenced more readily. This may account for the selective actions of poisonous drugs which act indifferently on other tissues, yet always produce a most conspicuous effect on the central nervous system.

II. Direct or Local Action.—This is produced on any organ with which the drug comes into contact, as seen in the case of swallowing a corrosive poison which injures the mucous membrane of the stomach; or in the application of cantharidin which causes irritation of the skin. It is an action produced by a drug before its absorption into the circulation.

III. Indirect or Systemic Action.—It is an effect produced by a drug after absorption on an organ through the intervention of some other structure, such as the nervous system, on which the drug acts. It is a secondary effect, the result of the direct effect, as seen in the mouthful of brandy reflexly stimulating the heart and respiration. The *action of digitalis on the circulation or the kidneys is the systemic effect of a drug after absorption.*

IV. Remote Local Action.—This is a physiological effect produced by drugs during the process of their elimination from the system. They frequently resemble the immediate local action. The drugs in passing through the excretory organs may act on :—

(*a*) The kidneys, stimulating the cells and producing a diuretic action ; or they may disinfect, alkalise or acidulate urine ; or diminish the quantity of urine.

(*b*) The bronchial mucous membrane, stimulating it and increasing the amount of bronchial secretion, disinfecting or liquefying it ; or by stimulating the muscular fibres in the bronchioles, increase their expulsive power and thus act as expectorants ; or they may, on the contrary, diminish the bronchial secretion.

(*c*) The skin, stimulating the sweat glands, and producing a diaphoretic effect, and thus increase perspiration; or they may decrease perspiration and act as anhydrotics.

(*d*) The alimentary tract, increasing or decreasing the flow of saliva, bile or intestinal secretion, and act as purgatives or astringents.

(*e*) The mammary glands, increasing or diminishing the secretion of milk (if present), or changing the quality of milk.

Chemo-therapy.—The knowledge of pharmacological action of the drugs is useful to counteract the distressing symptoms of the disease which eventually destroys the cause of the disease without directly acting on it. The causative factor of the disease may be a micro-organism or a parasite, and the aim of chemo-therapy is to destroy these pathogenic organisms that infest the human blood particularly Protozoa which do not produce antibodies of sufficient potency to eliminate the infection and make the patient immune. Efforts are being made to construct chemical agents by synthesising in the laboratory substances, having sufficiently marked germicidal powers, in such a manner as to increase their specific germicidal activity without being toxic to the tissues of the body in the form and quantity used. Or in the words of Elrich, who did pioneer work in the chemotherapeutic studies, the chemical agent so formed must be maximally parasito-trophic and minimally organo-trophic; for, the substances which are toxic to the parasite are also toxic to a certain degree to the tissues of the body. These chemical agents to be of use therapeutically, therefore, must have a high chemo-therapeutic index which is obtained by dividing the maximum dose tolerated by the individual by the curative dose. The action of these chemical agents according to Elrich is that the synthesised substance got attached to the protoplasm of the parasite and then the organic radical produced its toxic action on it.

It has, however, been found out that the organic compounds so formed have no action on these parasites outside the body in a test-tube experiment; besides the same compound which was found to cure one species of animal infected with a particular parasite failed to cure another species infected with the same parasite. Moreover our knowledge of chemistry of the protoplasm of parasite is still very meagre to say definitely about its chemical combination with the drug.

These facts abundantly prove, according to Dale of Toronto, that the chemo-therapeutic drugs so found do not kill the parasite directly as was supposed by Elrich but in some other way: "It may be acting to destroy the parasite by lowering its resistance to the natural defences of the body or it may be undergoing conversion within the body to some substance toxic to the parasite."

Dale, therefore, defines chemo-therapy as "the specific treatment of infection by artificial remedies." Specific in the sense that each chemical agent selects a particular parasite for its action at the exclusion of others without being toxic to the host.

Theories of Physiological Action

It is not easy to explain how exactly the different drugs produce their pharmacological actions. A living cell may be considered a complex laboratory where chemical decomposition and synthesis, reduction and oxidation, etc., are constantly going on. These changes lead to transformation of energy which gives expression in the phenomena of life. Foreign substances may enter into these reactions and thus modify them more or less profoundly with corresponding changes of functions. To produce these changes of functions the substances or drugs may act physically, chemically or by ionic dissociation. The action of some of the drugs may be explained on this basis. Yet the actions of many of the drugs are produced differently and cannot be explained by physical or chemical laws. They are explicable on the basis of the affinity that a drug has with a certain class of tissues or organs and this preferential effect of the drug is known as the selective action.

The Physical or Mechanical Action of a drug in an organism is seen in cases of oils, gums or mucilagines. These act on tissues by coming in contact with them. Many saline purgatives which act by salt action are also physical in their action, *i.e.*, they act by causing a difference of osmotic tension due to their having a greater (hypertonic) or weaker (hypotonic) salt value than that of blood plasma. A few of the drugs have the power of remaining in lose combination with blood, lymph and tissues, and give rise to specific effects, *i.e.*, they remain absorbed in these tissues, till their action is manifested. There are certain substances which are absorbed into the blood unchanged, but on account of their ready solubility in lipoids (fat-like substances which can be extracted by means of ether), they tend to collect in those parts, where lipoids exist. The hypnotic action of some of the drugs can be explained on this basis. Alcohol also acts in the same way.

The Chemical Action of drugs may be of the type seen in a chemical laboratory and consists of neutralising some substances in the blood and in the tissues. Alkalies taken by the mouth neutralise the acidity of the gastric secretion and when absorbed into the blood they increase its alkali reserve. In the great majority of drugs, however, the chemical action produced on an organism is not so simple. But certain facts in the study of the chemical reaction of drugs on the living protoplasm have come to light, which should be noted. These are :—

1. The intensity of the chemical action of a drug is proportional to its atomic weight. The heavier the weight, the more intense is the action. This is only possible in those compounds which crystallise in the same form (isomarites).

2. Drugs having the same chemical composition often produce similar pharmacological action. This fact has led to the introduction of the synthetic drugs into pharmacology. Drugs identical in composition with the active principles of crude drugs are prepared in a chemical laboratory and are used to replace the natural drugs to produce similar action.

3. By changing the molecular arrangement of the drugs which have the same composition, compounds having different properties are produced, *e.g.*, Resorcin has a sweet taste, but Pyrocatechin, which has the same formula as that of resorcin but a different molecular arrangement, has a bitter taste.

4. By the substitution of one radical for another in an artificially made organic compound of known constitution, it is possible to modify the physiological action of drugs, *e.g.*, if Strychnine, Brucine and Theibane are converted into Methyl strychnine, Methyl brucine and Methyl theibane, the convulsive action of these original drugs is replaced by a paralysing one.

The Ionic Action is due to electrolytic dissociation of ions in solution. Drugs are divided into two groups, electrolytes and non-electrolytes. Those that are capable of being decomposed by a constant electric current are called electrolytes; such are inorganic acids, salts and bases in solutions. Those drugs that cannot be further decomposed without losing their chemical identity are called non-electrolytes. Electrolytic drugs undergo partial decomposition into their constituent elements or ions which may act by entering into chemical combinations with protoplasm producing various compounds, synthesis and decompositions and thereby leading to functional changes. Besides these chemical actions it is probable that the ions carry electric charges which exert actions that are independent of the chemical nature of the ions. The basic radicals and metals are charged with positive electricity and are called *plus* ions or kations, while the acid radicals are charged with negative electricity and are called *minus* ions or anions. The ionic theory assumes that the action of a drug is dependent on the absorption of individual ions and not of the whole salt. In poisonous salts, the action of the basic ion predominates while in non-poisonous ones, the absorption of an acid ion exerts its influence. When none of the ions is potent enough, to exert action, the typical salt action, *i.e.*, osmosis is produced. Thus, the ionisable substance when introduced into the body has a three-fold action, *viz.*

1 That due to kation, as seen in the administration of ferrous sulphate, where the action of ferrum predominates.

2. That due to anion, as seen in the administration of sodium sulphate, where the action of sulphate predominates.

3. That due to salt action, as seen in the administration of sodium chloride, where the effect of both the ions predominates.

Standardization of Drugs

OWING to the variation in quantity of the active principles found in the crude vegetable drugs, the preparations of such drugs become undesirable from the therapeutic point of view and that is especially so when the crude drug is of a poisonous nature. This variation in quantity of the active constituents of a drug is due to (1) the character of the soil in which it grows, (2) the seasons in which it is collected, (3) the age of the plant at which it is collected, (4) the nourishment that is supplied to the plant to help its growth, and (5) the duration of storage after it is picked up. In order to insure uniformity of action in preparations of drugs having powerful active principles, it is necessary to fix the doses of the preparations not by the quantity of the crude material but by the quantity of the active principle they contain. The pharmacopœia, therefore, directs that preparations of poisonous drugs shall be made to contain a certain fixed proportion of the chief active principle. This is called *standardization* or *pharmaceutical assaying*. The methods used in assaying are chemical or physiological.

(*a*) The drugs whose chemical composition is definitely known are standardized by chemical methods of quantitative analysis either volumetric, gravimetric or gasometric, be they of inorganic or organic origin. Preparations of arsenic, strychnine, opium, belladonna, etc., are standardized by this method.

(*b*) The drugs of vegetable origin, which depend for their activity on neutral principles or bodies, whose composition is not definitely known, are standardized by pharmacological methods of biological assaying. It consists in estimating the strength of preparations, by (1) observing, either the minimum fatal dose when administered under similar conditions to animals of the same species and weight, or (2) observing the degree of some striking physiological effect, in intact animal or (3) noting the amount required to produce a definite effect on an isolated organ suspended in an approximate fluid. Preparations of Digitalis, Ergot and Adrenaline, Insulin, Pituitary extract, Supharphenamine, are standardized by biological assaying. In biological assaying the effects of a preparation to be assayed must be qualitatively identical with those of a standard supplied for the B. P. preparations by the National Institute for Medical Research, London.

Antitoxic sera are also standardized by biological assaying noting the quantity necessary to kill or neutralise a certain quantity of bacteria or bacterial toxins.

Principles of Medicinal Combination

An effective combination of drugs in a prescription should be the aim of the prescriber. Judiciously selected preparations are combined in a prescription with some objects in view and these are: (1) to augment, correct or modify the action of a drug used as a base; (2) to obtain the joint co-operation of two or more drugs; (3) to obtain a new remedy not afforded by a single substance; (4) to afford a suitable form.

1. **We can augment an action of a drug,** by (*a*) combining different preparations of the same drug. For instance, the full effects of calumba can be obtained by combining its tincture and infusion in the same prescription. It is an effective combination when all the active principles are not soluble in the same vehicle; (*b*) by combining with it substances which produce similar effects. The combination of

the salts of sodium and potassium acts as a better diuretic than any of these given singly; (*c*) by combining with it substances of different natures, which can in some unknown manner enhance its action. The diuretic effect of squill is increased by the addition of mercury. The purgative action of jalap is greatly assisted by ipecacuanha. **We can correct or modify the action of a drug,** by (*a*) chemically neutralising or mechanically separating the offending ingredient; or (*b*) by combining with it substances capable of protecting the stomach or system from its injurious effects. Essential oils are combined with purgatives to correct their griping tendencies. The tendency of mercurial salts, which affect the bowels, is corrected by an addition of opium, while the constipating effects of the latter are corrected by the former. The griping of the resinous purgatives is corrected by an addition of alkaline salts.

2. **The co-operation of two or more drugs** can be obtained by (*a*) combination of substances which have a different mode of action, and which effect the same or different results, a combination of purgatives, which act by increasing the peristaltic action, with that of purgatives which cause an increase in the intestinal secretion, the same effect can be obtained; (*b*) by admixtures of drugs having different physiological actions to achieve different results, as a combination of purgatives with drugs which produce a sedative effect on the brain. Such combinations are only intended to obviate different symptoms.

3. **We may obtain a new remedy of increased potency** not afforded by a single substance, by (*a*) combining drugs having different physiological effects. The official Pulvis Ipecac. et Opii, is an example in point. There opium and ipecacuanha, the main ingredients in the powder, when taken separately do not exert any powerful action on the skin, but their combination is remarkable for its diaphoretic properties. Iron and digitalis in combination are more powerful cardiac

tonics than when they are given separately; (*b*) a new remedy may also be produced by combinations of substances which are capable of reacting chemically on each other. The combination of ferrous sulphate and potassium carbonate in the Blaud's Pill of the B. P. to obtain ferrous carbonate is another example in point.

4. A suitable form of mixture may be written by having regard to taste, appearance, consistence, and preservation of medicine. A prescription sometimes contains substances which have not much therapeutic value but are intended to cover the nauseous taste of drugs. Extract Glycyrrhizæ Liq. is generally added to cover the nauseous taste of ammonium chloride; mucilage, to get an equable mixture in the case of oily drugs; Tinct. Cardamomi Co. to give pleasing appearance to mixtures devoid of any colour; citric acid, to remove the dirty black appearance of mixtures containing iron and tannin.

Weights, Measures, Symbols

THE English official standards of weights and measures are those of Imperial System and Metric System.

Imperial System.

Measures of Mass (Weights) Avoirdupois

The unit of weight is one grain.

1	grain	..	.. ..	Symbol	gr.
437·5	grains	=	1 Ounce	,,	oz.
7000·0	,,	=	1 Pound or 16 ozs. ..	,,	lb.

The weights of a drachm and a scruple are not official. They are respectively equal to 60 grs. and 20 grs. each. Their respective symbols are ʒ, ℈.

Measures of Capacity (Volume)

The unit of capacity is one minim.

1 minim	..	.. ..	..	Symbol min.,	m.
60 minims	=	1 fluid drachm	..	„ fl.dr.	ʒ.
8 fluid drachms	=	1 fluid ounce	..	„ fl.oz.	℥.
20 fluid ounces	=	1 pint or octarius	..	„	O.
8 pints	=	1 gallon or congius	..	„	C.

The symbols of ℈, ʒ, ℥, are not official but are found to be convenient in the writing of prescriptions. The letters "fl." prefixed to the symbols signify "fluid," and the letters "ss" when affixed signify "half" (semis.)

Relations of Measures to Weights

1 minim of water weighs			= 0·9114 grain at 62°F. (16·7°C)
1 fluid drachm	=	60×0·9114	= 54·687
1 „ ounce	=	8×54·687	=437·5
1·097 minim	=	1÷0·9114	=1 grain
109·7 minim (roughly 110)			=100 grains
∴ 1 grain in 110 minims			=1 % solution

Metric System

It is the name given to a decimal system of weights and measures, in which the unit of any denomination is multiplied or divided by 10 so that each preceding unit is just 10 times smaller than the one that follows. This system is in general use in France and the greater part of the Continent of Europe. Scientists of all nations prefer it to the ordinary system because it greatly facilitates their calculations.

Measures of Mass (Weights)

The unit of weight is one gramme.

1 milligram.	=	0·001 part of gramme. Symbol.	mg.
1 centigram.	=	0·01 ,, ,, ,, ,,	cg.
1 decigram.	=	0·1 ,, ,, ,, ,,	dg.
1 gramme.	=	weight of 1 millilitre or cubic centimetre of distilled water at 4° C. ,,	Grm.
1 decagram.	=	10 grammes.. .. .. ,,	Dg.
1 hectogram.	=	100 ,, ... ,,	Hg.
1 kilogram.	=	1000 ,, ... ,,	Kilo or Kg.

Measures of Capacity (Volume)

The unit of capacity is one millilitre or cubic centimetre.

1 centimil	=	the Vol. at 4° C. of	0·01	grm. of water.	Symbol	cl.
1 decimil	=	,, ,,	0·1	,, ,,	,,	dl.
1 millilitre	=	,, ,,	1	,, ,,	,,	Mil, C.C.
1 centilitre	=	,, ,,	10	,, ,,	,,	Cl.
1 decilitre	=	,, ,,	100	,, ,,	,,	Dl.
1 litre	=	,, ,,	1000	,, ,,	,,	1 Kg. or Kilo.

Conversion of Imperial to Metric

Weights		Capacity		
1 gr. =	0·065 grms.	1 min.	=	0·059 millilitre.
1 oz. =	28·349 ,,	1 fl. dr.	=	3·551 ,,
1 lb. =	453·592 ,,	1 fl. oz.	=	28·412 ,,
		1 pint	=	568·245 mils. or 0·5682 litre nearly.
		1 gallon	=	4·5 litres.

Conversion of Metric to Imperial

Weights		Capacity		
1 gramme =	15·432 grs.	1 mil. or c.c.	=	16·9 min.
1 kilogram =	15432·36 grs.	1 litre	=	35·196 ozs. nearly.
,,	35·274 ozs.	(1000 c.c.)	=	1·760 pints ,,
,,	2·205 lbs.			

Domestic Measures

For the convenience of the patient who is ordered by the physician to take his regular supply of daily medicine from a stock-bottle at home and of those who have not the requisite means of weights and measures at their disposal, it is necessary to order them to measure the quantity of their daily dose in certain utensils of common domestic use or to weigh them by the standard of the current coins. The domestic measures of capacity are spoons of different sizes and cups which are available in every household; and the coins for weighing available in India is the rupee and its smaller denominations in silver.

Indian Coins and their equivalents in Grains

1 Rupee or 1 Tola = 180 grains.
½ ,, ,, ½ ,, = 90 ,,
¼ ,, ,, ¼ ,, = 45 ,,
⅛ ,, ,, ⅛ ,, = 22·5 ,,
1 Copper Pice = 100 ,,

Domestic Measures and their equivalents in Drachms and Ounces

A tea-spoonful = 1 fluid drachm.
A dessert-spoonful = 2 ,, drachms.
A table-spoonful = 4 ,, ,,
A wine-glassful = 2 ,, to 2½ fluid.
A tea-cupful = 6 ,, ounces or more.
A tumblerful = 10 to 12 fluid ounces or more.

These are average measurements and cannot be relied on when accurate quantities are to be taken.

Sometimes, medicines are ordered to be taken in "drops" on the supposition that a "drop" is equivalent to "about a minim." But as the drop varies with the density of the fluid, and the opening of the container through which it is dropped, a drachm of fluid may be of 40 to 150 drops. For instance a fluid drachm of water measures 45 drops. while a fluid drachm of Tinct. Opii will yield 120 drops. Potent drugs should, therefore, be not ordered by the drop method. Officially when the term "drop" is used, the measurement is to be made, in accordance with International Agreement, by means of a tube which delivers in 20 drops 1 gramme of distilled water at 15° C.

The Method of Calculating Percentage Solutions

THE preparation of the percentage solutions varies according to the purpose for which they are intended. They may be prepared either in terms of weight or of volume of the solvent. In scientific research all quantitative estimations are made by weighing both the solute (substance to be dissolved) and the solvent. In these solutions a known weight of the substance is dissolved in a definite quantity of the solvent. The volume of the solvent is not taken into consideration as it varies according to its density. For instance, the weight of a given volume of glycerine differs from that of the weight of the same volume of water. Such solutions, which are known as true percentage solutions, are not necessary in the compounding of medicinal substances. Medicinal percentage, otherwise called conventional percentage, solutions are generally in terms of volume of the solvent. A definite weight or volume of a substance is dissolved in a known volume of the solvent. In the Metric System these solutions are easily prepared as the standard of measurement for weight as well as capacity is the same, *i.e.*, gramme. But in Imperial System this calculation becomes difficult owing to the fact that a minim of water is not equivalent to a grain. The weight of one minim-volume is 0·9115 grains (Avoir.) and that of 480 minims, or one fluid ounce is equal to $(480 \times 0{\cdot}9115) = 437{\cdot}5$ grains. It, therefore, follows that a volume of 480 minims or one fluid ounce of water is equivalent in weight to 437·5 grains (Avoir.); and on percentage basis 4·375 grains dissolved in sufficient quantity of water and made upto one fluid ounce will give 1% finished solution. The precaution of dissolving the substance first in a small quantity of the solvent before adding the solvent to the required quantity must be observed for if the substance is dissolved inthe total quantity of the solvent at once, the weight of the volume of the solution will change and the percentage will go wrong.

Taking 4·375 grains dissolved in one fluid ounce of water as 1% solution for the basis of calculation, we can find out not only the weight of an active ingredient necessary to prepare a solution of definite percentage and quantity, but also the percentage of the solution when the weight and quantity are given, as well as the quantity when the percentage and weight are given. The only precaution that must be taken in calculation is that the weight must be in grains and the quantity in ounces.

The formula resolves into this :—

Weight of substance(in grains) = 4·375 × Percentage × solvent (in ozs.)

The following rules will, therefore, prove useful :—

Rule I.—To arrive at the weight of the ingredient for preparing a percentage solution, multiply 4·375 grains by the required percentage and by the quantity of the solvent in ounces.

Example :—Required the weight of the substance necessary to prepare a 0·5% solution in a pint of water. (1 pint=20 ozs.)

4·375 × ·5 × 20 = 43·75 grains.

Rule II.—To arrive at the percentage of a solution, divide the weight in grains of the substance by 4·375 grs. and the quantity of the solvent in ounces.

Example :—Required the percentage of a solution in which 43·75 grains are dissolved in 20 ounces of the solvent.

$$\frac{43{\cdot}75}{4{\cdot}375 \times 20} = \frac{4375}{100} \times \frac{1000}{4375} \times \frac{1}{20} = \tfrac{1}{2}\ \%,\ \textit{i.e.},\ 0{\cdot}5 \text{ per cent.}$$

Rule III.—To arrive at the quantity of a solvent, divide the weight in grains of the substance by 4·375 grains and the percentage given.

Example :—Required the quantity of the solvent necessary to prepare 0·5 % solution with 43·75 grains of the ingredient.

4·375 × 0·5 100 4375 5 = 20 ozs.

Art of Prescription Writing

PRESCRIPTIONS are extempore formulæ, written in Latin, usually at the bedside, to combat specific conditions. They must be neatly and clearly written without ambiguity or doubt for the compounder as to what is intended. It may be simple, containing a basis and a vehicle or excipient only, or it may be complex containing besides the basis, other drugs to correct or help its actions.

A model complex prescription consists of the following parts :—

1. **Superscription,** which consists of the regular sign ℞ which is an abbreviation of the Latin word Recipe meaning " take thou "; and anything written above it to form a part of the prescription, such as name and address of the patient.

2. **Inscription** or the body of the prescription which consists of the names and doses of the drugs ordered. It contains the basis or chief ingredient, the adjuvant or auxiliary to assist the action of the basis, the corrigent or corrective, to correct the undesirable qualities of the two preceding, and the vehicle or excipient to give a suitable form of administration.

3. **Subscription** is made up of the directions in Latin for the guidance of the dispenser. Such as Misce. fiat mistura which means " make it into a mixture " and written in abbreviation as M. ft. mist.

4. **Signature** includes directions to the patient. These are generally written in English or in the language of the country. It also includes the physician's name.

The quantities of the drugs in the prescription are written either for a single dose and the dispenser is asked to supply a definite number of such doses or sometimes calculations of each ingredient for a certain number of doses are made by the physician himself and such quantities are written before the ingredients with instructions to the dispenser to divide the mixture thus obtained into the requisite number of doses.

When the compounded prescription is to be administered as a single dose the direction to the dispenser is "to make into a draught," the Latin equivalent of which is Misc. fiat Haustus.

An example of a written prescription :—

Patient's Name.

Superscription	℞	
Inscription	Magnesii Sulphatis (basis).	ʒii
	Infusum Sennæ Concentratum (adjuvant).	m. xx
	Spiritus Ammoniæ Aromaticus (corrigent).	m. xx
	Extracti Glycyrrhizæ Liquidi (sweetening agent).	m. xxx
	Aquæ. (Vehicle). .. .. Ad.	℥i
Subscription	.... Misc. fiat Haustus.	
Signature	To be taken early in the morning. Physician's Initials.	

The prefix "Ad." to the quantity of the vehicle means that after measuring and mixing up all the ingredients in the prescription, the vehicle is to be added upto the total quantity mentioned in the prescription, *i.e.*, if the quantity of the vehicle mentioned is ad. 1 oz., the prescription after compounding should measure 1 oz. including the quantity of the vehicle and other liquid substances in the prescription. If the word is omitted the bulk of the mixture would be over and above the quantity of the vehicle.

In writing prescriptions abbreviations should be avoided, and if used they should be so formed that there should not be any ambiguity about them in the mind of the dispenser. Ambiguous abbreviations have caused serious mistakes and have endangered the lives of the patients. It is a good practice to write the names of poisonous drugs always in full. Abbreviation "Ammon." may stand for Ammonia or Ammoniacum; "Chlor." may stand for Chlorine, Chloral, or Chloroform; "Bell." may signify Bellæ or Belladonna.

The art of dispensing can only be mastered at the dispensing table, under the guidance of an expert. It is entirely a practical art which cannot be acquired from books alone. The dispenser should, however, bear in mind the following rules:—(1) Read the prescription carefully, scrutinize the dose, seek for an incompatibility and see whether the quantity ordered is for a single dose or for several doses. (2) Write out the label with name and directions as given in the prescription; do not omit the date. (3) Mix the different ingredients in the order of their solubility. (4) Every item in the prescription should be carefully measured and there should be no guess-work. (5) If there be more salt in a prescription than the vehicle can dissolve, do not use heat for its solution, better suspend it by mucilage. (6) In case of an overdose of a poisonous drug, look for the prescriber's initial and if it is not present, return the prescription with a note for initialling the dose. (7) The incompatibilities in a prescription are generally intentional, but if there is any likelihood that the new body formed is dangerous, communicate with the prescriber. (8) If the prescription contains any insoluble matter or forms any poisonous precipitate in the compounding of it, put on the label "shake the bottle."

Hints on the Compounding of different Preparations

Mixtures.—Mixtures are made wholly of fluid preparations or partially solid substances which may be soluble or insoluble in a vehicle. There is hardly any difficulty in compounding fluid preparations and soluble salts. The dispenser may mix the ingredients according to the order in which they are written or follow the rule of mixing first the alcoholic or spirituous preparations and then the syrups and essences. Whatever order is followed, the poisonous drugs in the prescriptions should be mixed last. It is only a precaution to avoid repetition. The chief aim in compounding a mixture is to avoid chemical decomposition taking place among its ingredients, unless such is the intention of the prescriber. If there is any likelihood of chemical decomposition taking place, the reacting ingredients should be separately diluted or suspended before mixing; the addition of glycerine prevents chemical changes and precipitation in a mixture. The less soluble powders and crystals are best triturated in a mortar before addition.

Suspension —Insoluble salts and powders, if ordered in a prescription, must be suspended in a viscous media which is generally a mucilage either of gum acacia or tragacanth. The amount of mucilage or gum necessary to suspend insoluble powders varies with the weight of the powder. Heavy powders require a larger quantity of mucilage than the light ones in the same quantity of mixture.

Emulsion.—The oils, fats and resins in a prescription are emulsified with the aid of an emulsifying agent. The mixture formed by the emulsification of these substances assumes a milky appearance and is called an emulsion. The common emulsifying agents are gum acacia and its mucilage, gum tragacanth and its mucilage, solutions of alkalies, particularly liq. potassœ, potassium carbonate and lime-water, milk, yolk of egg, and tinctures of drugs containing saponins in their composition, *e.g.*, tinctures senega and quillaia.

The object of emulsification is to break the insoluble oils or fats into minute particles and to cover over each of these with a thin film of emulsifying agent which keeps them suspended in the mixture and prevents their re-union. In a perfect emulsion the oil globules are invisible to the naked eye.

The process of emulsification consists of rubbing in a mortar a small quantity of the drug to be mulsified with powdered gum ; then by gradual addition and rubbing the remaining quantity of the drug is incorporated to form a paste, water is then added by constant stirring. When tinctures, spirits and acids are to be added to the emulsion, they must be first diluted with water before addition ; otherwise they tend to "crack" the emulsion or cause the separation of the oil from water. When volatile oils are prescribed with fixed oils, they are mixed and emulsified together. Volatile oils alone are best emulsified with yolk of egg. Alkalies, which saponify oils, and saponins are mainly used as adjutants to the emulsification of oils by gums. The emulsion formed by these alone is not lasting.

Gum-resins in a mixture require no emulsifying agent ; for when rubbed with water they form natural emulsions, as they contain in addition to their resins, as much gum as will suspend them when water is added.

Pills.—A prescription for a pill consists of solid mineral or vegetable substances, or some solid or soft extract or oils and an excipient. The use of an excipient is for binding the ingredients into a mass which must be sufficiently soft to admit of moulding and yet sufficiently consistent not to lose its shape. Sometimes the choice of an excipient is left to the dispenser; he has then to choose it to suit the ingredients. The most common are gum or mucilage, syrup of glucose, glycerine, glycerine of tragacanth, glucanth,—which is very nearly a combination of glycerine of tragacanth and syrup of glucose—soap, or soft extract of non-poisonous drugs as gentian. The choice of excipients is a matter of experience and of importance. The excipients which are incompatible with any of the ingredients of the pill, or those which unduly increase the size of the pill or make it either too hard or too soft, must be avoided. Pills are to be swallowed as a whole without chewing ; therefore, the weight of the pill should not exceed 4 or 5 grains, unless the ingredients are exceptionally heavy.

Soap is a good excipient for vegetable powders, extracts and gum-resins. It should not be used with acids, acid salts, metallic salts and preparations containing tannin. Powdered curd soap is preferable to hard soap. Glycerine of tragacanth is a good all round excipient and a small quantity of it is required to form a pill mass. In the making of pills of phosphorus, silver nitrate, silver oxide, potassium permanganate and other oxidising substances, kaolin is of great use in making a mass and then add a little paraffin to bind it. Alkaloids and other poisonous extracts and drugs when ordered in minute quantities, should be first rubbed with sugar of milk to fine powder and then made into a mass with mucilage or extract of gentian. The gross weight of such pills should not be less than one grain.

Preparation of Pills.—The ingredients are first rubbed to a fine powder in a mortar. If there are crystals they must be dried. The excipient is then added in a small quantity and thoroughly rubbed up with the powder until it makes a pill mass. If too much is added, it should be brought to proper pliability by the addition of some inert powder as starch, acacia or liquorice. The mass formed is put on a porcelain slab marked with equal divisions over which some dusting powder, such as French chalk, lycopodium or light magnesium carbonate, is spread to prevent its sticking to the slab and to facilitate its rolling into a pencil of uniform diameter. The pencil is then cut into the requisite number of pieces, which are turned into spherical shapes by rolling them between the thumb and the first two fingers and dispensed in boxes containing a liberal supply of dusting powder to prevent their sticking together.

The pills are sometimes coated with sugar, chocolate, varnish, or French chalk to disguise their taste. The coating, however, tends to interfere with absorption. A coating of keratin is given to resist the action of gastric juice but the coating is easily dissolved by the alkaline contents of the intestines and the ingredients are liberated there to exert their action.

Plasters—are generally prescribed for protecting against irritation, for giving support to parts or for slow conveyance of drugs to or through the skin with the idea of producing analgesic, blistering or counter-irritant effect. The B. P. plasters come in rolls of about 9 inches by an inch and a quarter, having lead plaster as a basis. These are now falling into disuse as their place is taken up by ready-made plasters with rubber basis. When a plaster is ordered in a prescription, the size and shape are usually indicated. Sometimes, the part to which plaster is to be applied is mentioned and the determination of size and shape is left to the judgment of the dispenser. Plasters for the breast are circular in size with a diameter usually of 5 inches. A central hole of about 2 inches in diameter is made to keep the nipple and the areola around it uncovered. A wedge-shaped piece of the plaster having the base at the circumference is cut off to assure the close fitting of the plaster to the curves of the breast. The plasters for the ears are of retort or crescentic shape.

The Preparation of Plasters.—Plasters are spread by two methods, by fusion or by boiling the plaster mass. The shape of the plaster about an inch bigger than the required size is cut from the material selected. It is then spread over and fixed to a soft even surface. The official plaster roll is then melted by pressing it against a heated plaster spatula. The melted plaster is collected on the shape of the plaster, cut out of either silk, linen or leather and spread evenly over it from the middle towards the margin, by means of a heated spatula, taking care to leave half an inch margin unspread. The plaster should then be lifted from its bed and set aside to cool.

The other method of spreading the plaster consists in melting the shreds of plaster mass of required quantity in a porcelain vessel and pouring the melted mass on the plaster shape for spreading.

Blister plasters are made by spreading emplastrum cantharidini by the flat of the thumb or by a flexible spatula made warm by rubbing. No heat is to be used in the preparation of blister plasters.

Powders.—A prescription for powders may be only of innocuous powders in a fine state of division or it may contain in addition crystals of drugs or some active ingredient. In compounding, all the ingredients are carefully weighed and if they all be in a powder form these should be intimately mixed with a spatula on a slab. Crystals and other lumpy masses should first be powdered fine in a mortar and other powders then incorporated with the pulverized mass. The active ingredient of the prescription should first be triturated in a mortar with some inert powder such as sugar of milk or calcium phosphate and the remaining substances then gradually mixed up with it. The powder mass thus prepared is then distributed in equal weight to the requisite number of small pieces of ordinary paper of the size of 4×5 inches, arranged in a row. It is not absolutely necessary to weigh out each powder. One can rely on the judgment of the eye, by a little practice; in distributing powders in equal bulks sufficient accuracy, however, can be obtained by flattening the powder mass on a piece of paper or a porcelain slab, squaring the edges and dividing it into the requisite number of equal parts by means of a spatula. The papers with the powders are then folded by a particular method which can be better learnt at the dispensing table than described here. Substances which are volatile, hygroscopic or liable to chemical decomposition should be folded in waxed or paraffin papers and better covered with tin foil. The powders folded should all be of equal size and dispensed in card-board boxes.

Ointments.—Ointments have a fatty basis which may be either hard or soft. The process of compounding ointments varies according to the consistency of the basis used by the prescriber. Ointments, having as basis soft materials, such as lard, soft paraffin or lanoline, are prepared by mixing the ingredients on a slab and then blending them with the basis by rubbing with a flexible steel spatula. When the basis used is a hard material, such as wax, or hard paraffin, it should first be melted in a porcelain capsule over a water bath. It is then cooled to the consistency of a soft mass and transferred to a slab. The ingredients are then incorporated with the basis thus melted by means of a flexible steel spatula. The mixing of ointments on a slab is suitable for small quantities of ointments. If the quantity is large, the ointments are best prepared in a mortar.

Vaseline is generally used as a basis for ointments meant for local effects. It does not turn rancid and may be used with oxidising drugs which will act on the lard. If the ingredients are meant to be absorbed, they are mixed with lanoline which is the most absorbent of the fats.

In blending the various ingredients with the basis, the following points should be noted :—

Powders, whether amorphous or crystalline, should be finely pulverized. Soluble powders or deliquescent salts should first be made into a paste with water.

Hard extracts, balsams and resins should first be softened with water, alcohol, glycerine or oil as the case may be.

Alkaloids should be dissolved in oleic acid by trituration and gentle heat.

Volatile substances should be added after other ingredients are well mixed so as to preduce evaporation to a minimum.

Ointments containing mercurial preparations and acids should be rubbed up with bone or box-wood spatula instead of a steel one as these substances corrode steel.

Lard, which has turned rancid, should not be used as a basis. If the ointment is likely to remain too soft owing to the prevailing high temperature a small quantity of melted indurated lard, suet or beeswax may be added to the basis. The liquid substance should be incorporated with a fatty basis by adding the liquid drop by drop and keeping the rotatory motion.

Ointments are dispensed in glass jars or chip boxes meant specially for the purpose.

Suppositories, Pessaries and Bougies.—These are solid preparations shaped so as to be introduced into the rectum, vagina and urethra respectively. In the preparation of these, the basis must be such as to melt easily at the temperature of the body. The official bases recommended are of theobroma and glycerine of gelatin. The last named is only used in making the suppositoria glycerini of the B. P. Oil of theobroma is a suitable basis, for it is bland and non-irritating; it is sufficiently firm to be handled at an ordinary temperature, though its melting point is below 35° C. The shape of a suppository is conical and its weight is officially fixed at 15 grs. although in practice this weight is very often exceeded. The shape of a pessary is oval and it varies in weight from 30 to 120 grs. Bougies are pencils weighing approximately 30 grs. Their length varies according to the length of the canal in which they are to be introduced. The shapes of these preparations are obtained by pouring the melted basis with the incorporated substances into metal moulds specially designed for the purpose. The incorporation of the various ingredients should be like those for ointments. The active substance is thoroughly mixed with the basis melted over a water bath. It is then allowed to cool by constant stirring till the mass assumes the consistency of thick cream. It is then poured into the mould which has been previously warmed and lubricated with olive oil or solution of soap. The whole is allowed to cool, and to ensure perfect solidification the mould is placed on ice. The superfluous material over the cavities is then trimmed off with a knife; the mould is then opened and the suppositories are lifted from their base, wrapped in tin-foil and dispensed in partitioned boxes.

PART II

General Pharmacology of Drugs

Classified according to the parts on which they act.

Section I.—DRUGS ACTING ON THE DIGESTIVE SYSTEM

A. Drugs acting on the Teeth and Gums.—The various preparations used to keep the teeth clean and free from decomposing material between them are called *Dentifrices* or tooth powders or pastes. These generally contain for their basis substances such as soap, chalk or charcoal, which by mechanically rubbing on the teeth ensure their cleanliness. Antiseptics, such as borax, carbolic acid, camphor, thymol, quinine are mixed with the basis to prevent decomposition of food-stuff lodged in the crevices of teeth. Astringents, such as myrrh, tannic acid, alum, are added to these powders to harden gums which are spongy and bleed on slight touch. The use of alum and mineral acids as astringents should not be continued long as they destroy the dentine of the teeth.

Dental Anodynes are drugs which relieve toothache. Toothache is caused by the exposure of the nerve filament due to the caries of the teeth and is best relieved by plugging the carious tooth with cotton wool soaked in creosote, volatile oil or carbolic acid. Solutions of opium, cocaine, charcoal, camphor, menthol and arsenious acid are also used to achieve the same purpose. To prevent the irritant and caustic action of some of these drugs spreading to the mucous membrane of the mouth the precaution of placing plain cotton wool over the original one must not be neglected.

B. Drugs acting on the Salivary Glands.—The secretion of the salivary glands, parotid and submaxillary, is dependent on the secretory cells of the glands and its nerve supply.

These glands are supplied by two sets of nerve fibres, sympathetic and parasympathetic. The sympathetic fibres reach the glands through the cervical sympathetic trunk and parasympathetic fibres reach the submaxillary gland through the chorda tympani nerve, a branch of the 7th cerebral nerve, and the parotid gland through the 9th cerebral nerve. These parasympathetic nerves have their centres in the medulla oblongata and are capable of being stimulated reflexly by afferent nerve endings of the glosso-pharyngeal and gustatory nerves in the mouth and of the vagus in the stomach. The stimulation of the sympathetic constricts the vessels of the gland, consequently blood flows slowly through it and causes the cells to secrete scanty and viscid saliva. The stimulation of the parasympathetic dilates the blood vessels of the gland and causes increase in the secretion of the saliva. The drugs which increase the secretion of saliva are called **Sialogogues.** These are divided according to their mode of action into two classes—local and reflex.

(*a*) *Local or Specific Sialogogues* act by stimulating the gland directly or by stimulating the peripheral nerve endings in it of the parasympathetic nerves, *e.g.*, Pilocarpine, Physostigmine, Compounds of Iodine and Mercury.

(*b*) *Reflex Sialogogues* act either by stimulating the peripheral endings of gustatory and glosso-pharyngeal nerves in the mouth, *e.g.*, Acids, Acid salts, Alkalies, Chloroform, Ether, Alcohol and all Pungent substances as mustard, ginger, etc., or by stimulating the vagus endings in the stomach, *e.g.*, nauseants and emetics especially Antimony and Ipecacuanha.

Besides by drugs the secretion of saliva is also stimulated by mere smell, or sight of appetising food. This is probably due to the nerves of smell and sight acting through the brain upon the medulla.

Antisialogogues or Antisialics are drugs that lessen the secretion of saliva. They may act by :—

(*a*) Paralysing the peripheral terminations of the secretory nerves, *e.g.*, Belladonna, Hyoscyamus and Stramonium.

(*b*) Depressing the irritated peripheral terminations of the glosso-pharyngeal and gustatory nerves, *e.g.*, Potassium Chlorate, Borax, Astringents, etc. These act by allaying inflammation of the mucous membrane of the mouth and thus lessening the irritation which produces salivation.

(*c*) Reducing the excitability of the reflex centres in the medulla and of the afferent nerves, *e.g.*, Opium, Morphine, Alkalies, Demulscents, etc.

(*d*) Reducing the vascularity of the glands by constriction of the blood vessels. This is achieved by stimulation of the sympathetic fibres, *e.g.*, Physostigmine.

Refrigerants are remedies which allay febrile thirst and produce a feeling of coolness. In fevers and other pathological conditions the secretion of saliva is considerably decreased causing dryness of the mouth and sensation of thirst. It is relieved by all acidulated and effervescing drinks, acid salts, acetates, tartrates, juices of fruits, etc.

C. Drugs acting on the Stomach.—The stomach is a reservoir of food. The food that goes there is acted upon by the gastric juice and the churning movement of the stomach converts it into a liquid or semisolid consistency, so as to pass more easily from the narrow orifice of the pylorus into the duodenum. The orifice is regulated reflexly by the degree of the acidity of the stomach contents and opens only when the food material reaches to the consistency of liquid by the process of digestion. Any deficiency in the quantity of gastric juice secreted or its component parts—rennet, pepsin and hydrochloric acid—and in the motility of the stomach wall, will, therefore, interfere with appetite and digestive processes. Such a deficiency occurs in convalescence after long continued illness. The drugs which increase the secretion of the gastric juice, excite appetite and improve digestive processes are called **Stomachics**; such are aromatics, bitters, pungent substances, alcohol, ether, etc. Stomachics are administered half an hour before meals. Their overdose, however, must be guarded against as they by over-stimulation cause nausea and defeat the purpose.

Stomachics may act by one of the following ways :—

(*a*) *Altering the vascularity of the mucous membrane of the stomach.*—The mucous membrane of the stomach is very sensitive to irritation. Even the presence of food in the stomach dilates the blood vessels. This increase in vascularity within limit not only helps secretory glands in the stomach but also facilitates absorption of food. Any irritant to the mucous membrane when given in small doses acts as a stomachic. There are some drugs which powerfully irritate the mucous membrane and are called **gastric irritants,** *e.g.*, Arsenic, Iron, Mercury, Senaga, Squill, Colchicum, Guaiacum, etc.

(*b*) *Acting on the nervous system either locally or reflexly.*—The drugs having irritant action in the stomach, if given in all small quantities, stimulate by local action the nerve endings in the stomach wall, produce a sensation of warmth at the pit of the stomach and stimulate gastric secretion, *e.g.*, Mineral Acids, Bitters, Strychnine, Ether, Volatile Oils, etc. There are, however, certain drugs, which act as stomachics without actually entering the stomach. These are known as **Bitters.** They act reflexly by stimulating gustatory nerves in the mouth, *e.g.*, Quassia, Calumba, Chiretta, etc. If the irritation of the nerve filaments is powerful, they produce gastric pain which is not desirable, and when pathologically such a condition occurs, drugs are given which allay pain and arrest vomiting. They are called **Gastric Sedatives.** They act either mechanically by forming a coating over the sensitive areas of the stomach, *e.g.*, Bismuth Salts, or by anæsthetic action on the nerve endings in the mucous membranes of the stomach, *e.g.*, Belladonna, Opium, Prussic Acid, Carbolic Acid, etc. There are a few gastric sedatives whose action is not known, such as Tinctures of Iodine and Ipecacuanha in drop doses.

(*c*) *Toning the musculature of the stomach.*—The movement of the stomach is in proportion to the increase of acid secretion of the stomach, and the drugs which cause this increase in the acid secretion will also cause increase in the churning movement of the stomach, *e.g.*, Mineral Acids, Bitters, Volatile Oils and other Stomachics. But Strychnine directly stimulates the plain muscles of the stomach wall.

(*d*) *By supplying the deficiency of digestive principles.*—The secretion of pepsin and pancreatic juice, the two main digestive principles, and hydrochloric acid, is deficient in old age and after long continued illness. By supplying their deficiency through oral administration either alone or in combination with dilute hydrochloric acid, appetite and digestive functions are greatly improved.

(*e*) *Altering the state of the lower portion of the intestinal canal.*—The secretion of the gastric juice is much impaired by a torpid state of the bowels as seen in atonic indigestion. By stimulating the intestinal movement and its secretion, the morbid condition of the stomach itself can be relieved by drugs which have a stomachic as well as a purgative action, *e.g.*, Aloes and Rhubarb.

Drugs decreasing the secretion of gastric juice.—Gastric secretion may be diminished by :—

(*a*) *Reducing the vascularity of the mucous membrane of the stomach, e.g.*, Astringents, both vegetable and mineral, and *Opium.*

(*b*) *Paralysing the Vagus endings in the stomach, e.g.*, Belladonna, Hyoscyamus, Stramonium.

(*c*) *Neutralising the acidity necessary to stimulate gastric juice, e.g.*, Alkalies such as Sodium Bicarbonate. These are largely employed before meals to check the flow of gastric juice.

(*d*) *Administration of the fats and oils.*

(*e*) *Administration of stomachics in large doses.*

Carminatives.—These are drugs used in flatulence and colic to expel gases from the stomach and intestine and to diminish pain. They may act by :—

(*a*) *Stimulating the mucous membrane of the stomach and intestine.*

(*b*) *Relieving spasms of their muscular coat* so as to give greater regularity to the ordinary vermical action of the intestine.

(*c*) *Preventing fermentation and decomposition of the gastric contents.*

(*d*) *Stimulating sensory reflex and causing relaxation of the cardiac orifice of the stomach*, bringing about eructations and relief of the distension of the stomach, *e.g.*, Aromatics, Bitters, Pungent substances, Volatile Oils, Alkalies, Asafetida, Ammoniacum, Valerian and Camphor.

Emetics.—These are drugs which induce vomiting. The complicated mechanism of vomiting is under the control of medulla oblongata; and apart from drugs, it may be excited to induce vomiting by unpleasant afferent impulses generated along the nerves of the organs of sense, stomach, intestine, kidneys, gall bladder, and uterus, and by poisons. Therapeutically, vomiting is induced by drugs acting locally on the stomach and centrally on the vomiting centre in the medulla or on both.

(*a*) *Local or Gastric Emetics* act reflexly, by irritating the sensory nerve endings of the stomach, *e.g.*, Mustard, Salt, Warm water, Alum, Ammonium, Carbonate, Copper Sulphate, Zinc Sulphate, Tartar Emetic, Ipecacuanha. The emetic action of these drugs ceases as soon as the drug is evacuated and it is not followed by general depression.

(*b*) *Central Emetics* act directly on the vomiting centre through the medium of circulation after absorption. Apomorphine is the only drug which acts this way.

(*c*) *Mixed Emetics* act on the stomach, are absorbed in the circulation to irritate the vomiting centre and are excreted again by the mucous membrane of the stomach to irritate the sensory nerve endings. The vomiting caused by such drugs is more prolonged and is followed by great depression, *e.g.*, Antimony and Ipecacuanha.

The act of vomiting is generally accompanied by ***side actions***, such as general depression, nausea, langour, muscular weakness, enfeeblement of circulation and increase of secretions especially of saliva, sweat, and of mucous in the œsophagus, stomach and bronchial tubes.

Emetics are generally used to remove foreign bodies impacted in the throat or œsophagus, to expel contents of the stomach in cases of poisoning and indigestion, to remove accumulated mucous in the bronchial tubes, particularly in children in small doses they act as expectorants.

They are used with great caution in cases where there is a tendency of determination of blood to the head, in diseases of the heart and larger vessels, in hernia, in advanced pregnancy, in prolapse of the uterus and rectum, and in gastric inflammation.

Anti-emetics.—These are drugs which stop vomiting. They act locally by their sedative action on the gastric nerves or centrally by depressing the vomiting centre in the medulla. Most of the gastric sedatives act as anti-emetics. Tincture of Iodine, Ipecacuanha, and Arsenious acid all in minute doses act as anti-emetics and are used empirically. Alcohol, Carbolic Acid, Chloroform, Creosote, Silver Nitrate and Ether, when given in small doses also arrest vomiting.

Central anti-emetics are those sleep producing drugs which depress the vomiting centre, either by their direct action on the brain and medulla or by dilating the peripheral blood vessels, *e.g.*, Opium, Morphine, Salts of Bromine, Chloral Hydrate, Hydrocyanic Acid, Alcohol, Nitroglycerine, Amylnitrite, etc.

D. Drugs acting on the Intestines.—Drugs may act on the intestines by increasing or decreasing their peristaltic activity and their secretions. They may also act by increasing or decreasing supplemental intestinal secretion. Some of the drugs act on the micro-organisms in the small intestine and colon, while others act on the parasitic worms which infest the alimentary tract.

Purgatives—are drugs that increase the peristaltic movement and secretion of the intestine and induce defecation. They may act (*a*) by simply increasing the bulk of the intestinal contents, (*b*) or by preventing the absorption of water, (*c*) or by irritating the small or large intestines. Owing to the imperfect knowledge of the physiology of intestinal digestion, and of the movements and the nervous mechanism of the intestines, it is not possible to arrange the action of drugs on a purely physiological basis. They are therefore classified clinically according to their degree of action.

Laxatives—are substances which gently stimulate the peristaltic action without causing increase in the amount of secretion. These act chiefly by increasing the bulk of non-absorbent material and also by softening the fæcal mass, *e.g.*, Figs, Sulphur, Magnesia, Castor Oil, Liquid Paraffin, Agar, etc. These take about 10 to 18 hours to act.

Simple Purgatives—act by causing greater increase of the peristaltic action than the laxatives do and also by causing increase in the amount of secretion. They induce a mild degree of irritant action on the intestinal mucosa and reflexly increasing the peristaltic movement, *e.g.*, Aloes, Rhubarb, Cascara Sagrada, Senna, Purgatin, Phenolphthalein, Bile, Calomel, in small doses, etc. Of these, the first four are called **anthracene purgatives.** They owe their purgative property to emodine (trioxymethylanthraquinone), which is contained in their composition and is a derivative of anthraquinone. Senna and Rhubarb in addition to emodine contain chrysophanic acid (diaxy-methylanthraquinone) which is also an anthraquinone derivative. These purgatives act chiefly on the large intestines and colour the urine yellowish brown when it is acid and reddish when alkaline. Anthracene purgatives take 10 to 12 hours to act.

Drastic Purgatives—differ from simple purgatives in their degree of action. They induce vigorous peristaltic action of the intestine accompanied by griping pain and cause copious increase in the amount of secretion. They are often called cathartics, *e.g.*, Colocynth, Jalap, Scammony, Podophyllum, Aloes, Stronger mercurials, etc. Some of these, particularly Jalap and Scammony, excite a large amount of secretion and are called **hydragogues.**

Hydragogue purgatives are resin purgatives. These drugs contain glucosidal resins which in the alkaline intestine are split up with the liberation of irritant glucosides, by the aid of lipase and bile.

Cholagogue Purgatives—act by hastening the flow of bile into the intestine before being reabsorbed into the system; and they cause free evacuation of green coloured (bilious) and liquid stools, *e.g.*, Mercurials, Aloes, Rhubarb, Podophyllum, Euonymin, Sodium Sulphate, Sodium Phosphate, Colocynth, etc.

Saline Purgatives—produce an effect midway between simple and hydragogue purgatives. They cause liquid or watery motion by increasing the intestinal secretion and preventing its reabsorption. Owing to their low diffusibility they are not readily absorbed from the gastro-intestinal tract and they disturb the osmotic balance between the bowels and the surrounding tissues. Their action, therefore, depends on the concentration of the solution in which they are administered. If the solution of the salt taken by the mouth is concentrated (hypertonic), the osmotic pressure inside the intestine is set up, which attracts water from the tissues into the lumen of the intestines till the solution becomes of the same molecular concentration as that of blood (Isotonic). The increased bulk of the fluid in the intestinal canal stimulates the peristaltic action to cause watery evacuation. In an isotonic very little solution can be absorbed, and if some of the water from the solution is absorbed, the solution becomes concentrated and raises the osmotic pressure again inside the intestine which retards the absorption of intestinal contents. Very dilute solutions (hypotonic) of salts act as purgatives in certain diseases, provided a large amount of it passes into the large bowel to inhibit colon-anti-peristalsis and provoke defœcation. On the osmotic theory alone, every salt of metals ought to act as a purgative, but it is not so, for sodium chloride given in any concentration does not act as a purgative but sodium sulphate does. This shows that the kation sodium, which is common to both these salts has no purgative action nor has the anion chloride. But the anion sulphate of the salt Sodium sulphate has. To explain the purgative action of the salts of the metals Magnesium, Sodium and Potassium, the simple osmotic theory is not sufficient; the selective action of the intestinal epithelium for particular ions must also, in addition, be taken into consideration, for that it selects kation magnesium and anion citrate, phosphate, tartrate and sulphate for purgative action. These act as local irritants to disturb the osmotic balance.

Saline purgatives should always be given in the morning when the patient is up and moving; and for their better and quicker action they should be diluted with tepid water. If they fail to act, they are reabsorbed by the blood and excreted by the kidneys to act as diuretics, and this generally is the action if the patient rests or goes to sleep after a dose of saline purgative.

Uses of Purgatives.—To relieve constipation, to soften the stool in the hæmorrhoidal and other rectal diseases, to prevent straining in hernia and apoplexy, to increase secretion of neighbouring glands, to cleanse the intestine of putrefactive material, to facilitate absorption of dropsies, to relieve kidneys in nephritis, to lower temperature in fever and to relieve congestion of internal organs especially of the brain.

There are a few drugs, such as Nuxvomica, Belladonna, Ergot, etc., which act by stimulating or regulating the muscular activity of the intestines. These drugs are useful adjuncts to simple purgatives; given alone they act as laxatives.

Enemata.—In addition to the drugs, which act as purgatives there are many indirect remedies, which act with considerable efficiency such as enemata, cold to the abdomen, mechanical kneadling of the abdominal wall, electricity and others. Of these enemata are more certain in their action. They are also given for their medicinal and nutrient effects.

Purgative enemata consists of large quantities of fluid introduced for distension of the rectum, so as to reflexly stimulate the peristaltic action of the intestines, either to produce purgative, cleansing or gas-expelling action. They are also used to soften impacted fæces.

Medicinal enemata are meant for introducing drugs into the rectum so as to have either sedative, astringent, antiseptic or anthelmintic action as seen in the effects of the administration of opium, silver nitrate or tannic acid, boric acid or potassium permanganate and bitter infusions of salt water, respectively. As they are intended for absorption, or for continued local action, the quantity of the fluid must not exceed 8 oz. to one pint.

Nutrient enemata consists of beef tea, milk, eggs, gruel and such other food stuffs. These nutrients are introduced into the rectum to get them absorbed into the system and as such the quantity of fluid to be introduced, as in medicinal enemata, must not exceed 8 to 10 ounces.

Intestinal Astringents.—These are drugs, which act locally to decrease the movement and secretion of the intestines. They act by precipitating the proteins in the superficial layers of the mucous coat of the intestines. The precipitate so formed, acts as a protective coating which lessens the reflex peristaltic activity of the intestines with consequent delay in the transmission of the intestinal contents. The stagnancy of intestinal contents allows more time for its dehydration, and that results in constipation. Intestinal astringents are divided into two groups:—

(1) *Metallic Astringents.*—Lead acetate and soluble salts of iron, Silver-nitrate, copper, alum and zinc.

(2) *Vegetable Astringents.*—Tannic Acid and other crude drugs containing tannic acid in their composition such as Kino, Krameria and Catechu.

Uses of Astringents.—Astringents are antagonistic to purgatives. They are employed to check diarrhœa, to reduce inflammation of the mucous membrane, to promote healing and to arrest hæmorrhage by coagulating the blood and contracting the vessels.

Intestinal Antiseptics.—These are drugs acting on the micro-organisms in the intestines by preventing their growth or by completely destroying them. It is impossible to obtain the antiseptic action of a drug in the intestine, where bacteria remain locked up in the mucous membrane and the antiseptic properties of a drug are completely altered by the chemical composition of the gastric juice. The effect of a drug is still further nullified by the large mass of material in the intestines which prevent its access to the micro-organism. The drugs which exert their antiseptic properties must be given in larger quantities, so as to make their action felt in the colon, but these stronger antiseptics might destroy the mucous membrane or produce toxic action of these drugs. The remedy then proves worse than the disease. The intestinal antiseptic must be of such a nature, that it must not only produce or exert its antiseptic action in the lower part of the intestines and colon, but at the same time, it must be sparingly soluble so as to prevent its toxic action ; it must act in the alkaline medium and in the presence of organic matter. The drugs generally used as intestinal antiseptics are Naphthalene, Creosote, Thymol, Salol, Calomel, Cyllin, Lactic-Acid, All Aromatic Volatile Oils, Camphor, etc.

Anthelmintics—are drugs that expel or kill the parasitic worms infesting the intestinal canal. They have been divided into Vermicides which kill the worms and Vermifuges which expel the worms without necessarily killing them, as purgatives.

The chief worms whch infest the intestines are thread-worms, round-worms, tape-worms and hook-worms.

Anthelmintics are classified according to their actions on the various intestinal parasites.

(*a*) For Thread-worms (Oxyuris Vermicularis).—Rectal injections of solution of common salt, Tannin, Infusion of quassia and calumba, solutions of ferric salts, etc.

(*b*) For Round-worms (Ascaris Lumbricoides).—Santonin, and Oil of Chenopodium.

(*c*) For Tape-worms (Tænia Solium and Tænia Mediocanellata).—Filix-Mas (Male-fern), Oleum Terebenthinæ, Pelletierine Tannate.

(*d*) For Hook-worm (Ankylostoma-Duodenalis).—Thymol in large doses, Eucalyptus, Naphthol, Carbon-Tetra Chloride and Oleum Chenopodium.

For the effective action of anthelmintics it is customary to give a preliminary purge to expose the worm to the full action of the drug followed by a purgative to expel the paralysed worms. Anthelmintics should be administered on an empty stomach preferably at bed time.

E. Drugs acting on the Liver.—The liver is one of the most important organs in the body and has to perform important functions in the economy of life. The substances absorbed from the intestinal canal are carried to the liver through the portal vein before they enter the general circulation. There (*a*) it prevents the passage of injurious substances by metabolising amino-acids which are absorbed as the end product of protein digestion; (*b*) it converts poisonous ammonia salts into inert urea; (*c*) it stores the excess of carbohydrate material in the form of glycogen to evolve heat and muscular energy; (*d*) it secretes bile for the use of digestion and (*e*) it excretes bile with bile-pigments and with it, toxins and poisons which may have been formed in the alimentary tract during the process of digestion or introduced into it from without.

Hepatic Stimulants—are drugs which stimulate the functional activities of the liver and cause increase in the quantity of bile secreted.

Cholagogues—are drugs which are supposed to increase the secretion of bile alone. These are divided into direct and indirect.

(*a*) *Direct Cholagogues* are drugs which after absorption cause actual increase in the quantity of bile secreted and **bile** is the only drug that acts in this manner.

(*b*) *Indirect Cholagogues* are drugs which cause a contraction of the gall-bladder, for example fats, cream, yolk of an egg and hypertonic solutions of magnesium sulphate. The appearance of a large quantity of bile in the stools does not necessarily mean that the actual secretion of bile is increased by these drugs for it is possible that the gall-bladder may have emptied itself thoroughly into the duodenum, or that the bile poured into the duodenum may have been swept away by the vigorous peristaltic action of the upper part of the small intestine and had no time to get itself reabsorbed into the system. The majority of the purgatives and Mercurials act in this way. Other examples are—Podophyllum, Euonymus, Ipecacuanha, Acids—Nitric and Nitro-hydrochloric, Ammonium Chloride, Sodium Salicylates and Benzoates and others. Of these, the last two make the bile watery.

Therapeutic uses.—They are used in cases of dyspepsia in which there is reason to believe that the liver is the organ at fault.

Anticholagogues or Hepatic Depressants—are drugs which decrease the amount of bile secreted and depress the functional activity of the liver, *e.g.*, Castor Oil, Magnesium Sulphate, Opium, Morphine, Codeine and others.

Drugs influencing the formation of Urea in the Liver.—Ammonia salts and amino-acids such as leucine are converted into urea in the liver. This increase in the formation of urea is manifested in the excretion of urea in the urine, *e.g.*, Thyroid gland, Phosphorus, Arsenic and Antimony ; but these drugs are never used therapeutically for this purpose. The drugs which act as hepatic depressants will also cause the decrease in the quantity of urea excreted in the urine.

Drugs modifying the glycogenetic function of the liver.—Glycolysis is increased by adrenaline, pituitrin and thyroxine by mobilizing hepatic glycogen, as could be seen by the appearance of sugar in the urine. It is decreased by hypodermic injection of insulin and in a minor degree by morphine codeine and bile salts when administered by mouth.

F. Drugs acting on the Pancreas.—The increase or decrease in the secretion of pancreas is dependent on the presence or absence of secretion which is produced by the action of the hydrochloric acid on the duodenal mucous membrane. All stomachics, therefore, which increase the secretion of the gastric juice with the consequent increase in its quantity of hydrochloric acid, and other mineral acids taken by the mouth as also fats, will cause increase in its secretion. Alkalies taken by the mouth neutralise the acid in the stomach, inhibit the flow of gastric juice and thus diminish the secretion of the pancreas.

Section II.—DRUGS ACTING ON RESPIRATION

The act of respiration consists in alternate enlargement and diminution of the thoracic cavity, so that air is alternately inspired and expired. It is greatly influenced by the composition, moisture and pressure of the inspired air as well as by the changes in the blood and circulation. But when we talk of drugs acting on the respiratory mechanism, we mean only those drugs which modify the activity of the respiratory organs so as to either augment, decrease or alter the respiratory act. The respiratory phenomena may be interfered with (*a*) by inhalation of certain medicinal vapours with the inspired air, *i.e.*, by altering the composition of the air inhaled, (*b*) by influencing the respiratory centre either directly or reflexly, (*c*) by interfering with the muscular activity of the bronchi, and (*d*) by affecting the secretion of the bronchial mucous membrane.

A. Drugs acting by altering the composition of air inhaled.—These may be classified into :—

(*a*) *Stimulant Inhalations.*—These by increasing the vascularity, secretion and muscular activity of the bronchial tubes induce reflex cough from stimulation of the sensory nerves of the bronchial mucous membrane. Their general effect is to increase the activity of the respiratory centre and so of the thoracic movements, *e.g.*, Carbolic acid gr. 20 ; Cajuput Oil m. 20; Creosote m. 30 ; Cubebs Oil ½ oz. ; Tinct. Benzoin Co. ½ oz. The quantities indicated are to be added to a pint of water at a temperature of 140° F.

(*b*) *Soothing Inhalations.*—These decrease the congestion of the bronchial mucous membrane and thus lessen the irritation which induces a cough. Their general effect is to paralyse the sensory nerve endings in the bronchial mucous membrane, *e.g.*, Hydrocyanic Acid and Conium.

(*c*) *Antiseptic Inhalations.*—These disinfect and deodorise foul secretions from the bronchial mucous membrane, *e.g.*, Creosote, Iodoform, Carbolic Acid, Cubebs Oil, Juniper Oil, Solution of Benzoin, Sulphurous Anhydride.

(*d*) *Antispasmodic Inhalations.*—These relieve the spasms of the bronchial tubes, *e.g.*, Chloroform, Ether, Amyl Nitrite, Stramonium, Belladonna, Fumes of Nitre Paper.

B. Drugs acting on the Respiratory centre.—The respiratory centre in the medulla is peculiarly irritable and coincides with the centre of the Vagus nerve which is the chief nerve of respiration. The Vagus nerve is composed of both afferent and efferent fibres. Efferent fibres are motor and supply the muscles of the bronchial tubes, while afferent fibres are sensory and are distributed in the mucous membrane of the whole of the air passages including the lungs and through them the respiratory centre is reflexly stimulated to modify the respiratory movement. The stimulation of the glossopharyngeal and olfactory nerves in the mouth and nose respectively, and the cutaneous nerves from other parts of the body also help to modify the inspiratory and expiratory movements. The respiratory centre may thus be influenced either directly or reflexly to increase or decrease the number of respirations making them, at the same time, deeper or shallower.

(*a*) *Drugs acting directly to stimulate the respiratory centre* so as to cause increase in the number as well as the depth of respiration, *e.g.*, Strychnine, Atropine, Caffeine, Ammonia. The respiratory centre is also stimulated by gaseous changes in the blood owing to an increase of carbon dioxide or by any cause that tends to diminish oxygenation of the blood. The drugs stimulating the respiratory centre keep it in state of irritability so that the slightest reflex action starts a sudden fit of coughing and expels the accumulated mucous.

(*b*) *Drugs acting directly to depress the respiratory centre* so as to lessen the number of respiration and make them shallower, *e.g.*, all narcotics, anæsthetics and similar drugs which act as deadly poisons to all vital centres in the medulla. Normally the substances which depress the respiratory centre are very little needed for action, but the centre of the reflex act of coughing being close to the respiratory centre the depressants to the respiratory centre are very valuable in allaying spasmodic coughing which frequently accompanies diseases of the heart and lungs.

(*c*) *Drugs acting on the respiratory centre to stimulate first and depress afterwards.*—Certain drugs, such as general anæsthetics and nitrites, stimulate the respiratory centre for a while before depressing it.

C. Drugs affecting the Bronchi.—These may be divided into two groups. Those acting on the bronchial secretion, and those acting on the muscles of the bronchi. Drugs during their process of excretion through the bronchial mucous membrane either modify its secretion in quality and in quantity or relieve the spasm of bronchial tubes and cause easy expulsion of their contents. Drugs acting in such a manner are called **expectorants.** These are classified as follows:—

(*a*) *Irritant Expectorants.*—These increase the bronchial secretion by stimulating the vascularity of the bronchial mucous membrane. Most of them acting reflexly by irritation of the stomach, *e.g.*, Salts of Ammonium, Senega, Squills, Benzoin, Benzoic Acid, Balsam Tolu, Balsam Peru, Turpentine, Quillala.

(*b*) *Sedative Expectorants.*—These increase the bronchial secretion and at the same time depress the general circulation, *e.g.*, Alkalies, Antimony Salts, Ipecacuanha, Lobelia, Pilocarpine, Iodides, etc.

(c) *Antiseptic Expectorants.*—These during their process of excretion stimulate and exert an antiseptic action on the bronchial mucous membrane, *e.g.*, Phenol, Creosote, Iodoform, Sulphur, Iodine, Aromatic Oils, etc.

(d) *Antispasmodic Expectorants.*—These act by relaxing the spasm of the bronchial muscle by (*a*) direct action on the muscle, *e.g.*, Nitre-fumes, Amyl-nitrite, or (*b*) by paralysing vagus endings in the muscles, *e.g.*, Belladonna group, or (*c*) by stimulating the sympathetic endings which relax the muscles, *e.g.*, Adrenaline or (*d*) by depressing the respiratory centre, *e.g.*, chloroform, opium, chloral, (*c*) by paralysing autonomic ganglion, *e.g.*, Lobelia.

Expectorants are further classified according to their point of action :—

(a) *Central Expectorants.*—These act by stimulating the bronchial centre in the medulla oblongata. Apomorphine is the only drug which acts this way. Ipecacuanha is also said to have a partly central and partly local action.

(b) *Reflex Expectorants.*—These are drugs which reflexly stimulate the vomiting centre through afferent impulses from the stomach, *e.g.*, Alum, Ipecacuanha, Senega and Squill.

(c) *Local Expectorants.*—(1) Those acting by stimulating the secretory nerve endings, *e.g.*, Pilocarpine. (2) Those acting by stimulating the bronchial glands during the process of excretion through the bronchial mucous membrane, *e.g.*, Iodides, Chlorides, Alkalies, Saponins and Volatile oils.

Section III.—DRUGS ACTING ON THE HEART

THE heart is a peculiarly constructed organ of involuntary muscular fibres. It is capable of originating rhythmical contractions which manifest themselves as beats of the heart. The rhythmicity of contraction was at one time supposed to be due to spontaneous impulses proceeding from the cardiac ganglia located in and around the heart; but it is now proved that this pulsating rhythmicity is inherent in the muscles of the heart. It is controlled, like other organs of involuntary muscles, by the autonomic nervous system with its two divisions parasympathetic and sympathetic. The parasympathetic supply of the heart is through the fibres of the Vagus which has its centre in the medulla oblongata and its chief function so far as the heart is concerned, is of restraint or inhibition. Its stimulation, therefore, either at its centre or at its peripheral endings, is followed by the slowing or weakening of the movements of the heart and thus lessening the number of its beats; while its depression results in the increased frequency and strength of the movements of the heart with the consequent increase in the number of its beats. The sympathetic supply of the heart proceeds along the cervical portion of the spinal cord to the first thoracic ganglion, and from there to the cardiac plexus. It has also its controlling centre in the medulla. The function of the sympathetic system is of acceleration. Its stimulation, therefore, either at the centre or at the periphery results in strengthening and increasing the movements of the heart with consequent increase in the number of its beats. Its paralyzation at these points produces opposite effects. The parasympathetic and sympathetic systems are thus antagonistic in their action and between them, by their normal unconscious activity, they keep under control the rhythmical pulsation of the heart. It, however, responds to the slightest influences, reflexly transmitted to it through the inhibitory and acceleratory centres in the medulla from the various parts of the body including the seat of the mind.

The cardiac activity may be thus interferred with by drugs acting directly on the muscles of the heart so as to increase, decrease or alter its rhythmicity and force, or indirectly through its nervous mechanism, through its blood supply from the coronary artery or through the peripheral resistance. It must, however, be borne in mind that the action of a drug on the nervous mechanism in the wall of the heart of blood vessels is not readily distinguishable from the direct action of a drug on the muscles. It is, therefore, advisable to classify the drugs, acting on the heart, by the effects they produce on the movements and tonicity of the heart rather than by those affecting the muscles and the nerves. This therapeutical classification of drugs is made according to their action, into stimulants, tonics and depressants.

I. **Cardiac Stimulants** are drugs which increase both the force and number of beats of the heart, *e.g.*, Alcohol, Ether, Ammonia, Strychnine, Belladonna, Cocaine, Adrenaline, Ephedrine, Pituitary, Chloroform, Musk, Aromatic Volatile Oils, etc.

II. **Cardiac Tonics** are drugs which increase the force of contraction, affecting or not affecting the number of beats of the heart, *e.g.*, Digitalis, Strophanthus, Squill, Caffeine, Camphor, etc.

III. **Cardiac Depressants** are drugs which depress either the force or number of beats of the heart or depress both, *e.g.*, Chloroform, Chloral and others of the narcotic drugs, Aconite, Hydrocyanic Acid, Antimony Salts, Apomorphine, Veratrine, Alkaline Salts, Salicylic Acid and Salicylates, etc.

A. Drugs acting on the inhibitory nervous mechanism of the Heart.—The inhibitory mechanism of the heart consists of the Vagal nerve, its centre and terminal ganglia. Drugs may act on any one of them by stimulating or depressing them either directly or indirectly. The stimulation of any portion of the Vagus causes the slowing of the heart by prolonging the diastole, loss in force, muscular conductivity, and tone with increased relaxation, a condition disappearing on section of the Vagus; while the depression of these parts produces the contrary results.

I. Drugs acting on the Vagal Centre by—

(*a*) Stimulating it directly.—Digitalis, Strophanthus, Squill, Chloroform (in the early stages of its anæsthesia), and increased venosity of the blood.

(*b*) Stimulating it indirectly.—Strychnine, Adrenaline, Alcohol, Ephedrine and such other drugs which cause the rise of blood pressure, either by central or peripheral stimulation of the vasomotor mechanism. The irritant vapours of drugs stimulate the vagal centre reflexly, so also cold applied to the skin.

(*c*) Depressing it directly.—All narcotics and anæsthesia in later stages and large doses of drugs which stimulate it in smaller doses.

(*d*) Depressing it indirectly.—Reduction of blood pressure and substances causing that reduction such as Amyl Nitrite.

II. Drugs acting on the Vagal nerve-endings by—

(*a*) Stimulation.—Pilocarpine, Physostigmine, Muscarine, and Digitalis.

(*b*) Depression.—Atropine and its related alkaloids Hyoscyamine and Hyoscine.

III. Drugs acting on the Vagal ganglia situated at the base of the heart.—The drugs acting on the Vagal ganglia in the heart at first stimulate them to cause the slowing of the heart, but later on they paralyse the ganglion cells and cause the heart to become weak, rapid and irregular, *e.g.*, Nicotine, Conine, Lobelia, Gelesmium.

B. Drugs acting on the Acceleratory Mechanism of the Heart.—The acceleratory mechanism of the heart consists of the sympathetic ganglia and nerves and the acceleratory centre in the medulla controlling them. The stimulation of these parts excites the activity of the heart which is rendered still more active after the Vagi have been cut. Very little is known about the drugs which modify the activity of the accelerator mechanism. The accelerator centre is stimulated by Ammonia and Apomorphine. Cocaine probably stimulates the accelerator centre. Acceleratory nerve endings are stimulated by Adrenaline and Cocaine and perhaps by Caffeine. Nothing definite is known of drugs that depress the accelerator nerves.

Section IV.—DRUGS ACTING ON THE BLOOD VESSELS

THE arteries contract by the action of the involuntary muscular fibres contained in their walls. They dilate partly by their own elasticity and partly by the pressure of the fluid within them. This dilatation and contraction of the blood vessels is controlled by the vaso-motor nervous mechanism which consists of a centre in the medulla and sets of nerve fibres—vaso-dilators and vaso-constrictors—running together in the same nerve trunks that proceed from different parts of the central nervous system. Normally all the blood vessels in the body are in a state of contraction. It is partly maintained by impulses from the vaso-motor centre and partly due to the stimulation of the Vaso-constrictor nerve endings in the walls of the arteries by the pressure of the blood flowing through them or it may be due to their stimulation by the internal secretion of adrenaline, pituitary and thyroid glands. It should, however, be noted that some of the arteries—Coronary, pulmonary and cerebral—have no Vaso-constrictor nerves. The tone of the arteries is essential to the circulation of blood by providing the necessary peripheral resistance for promoting a continuous flow of the blood through the capillaries. The capillaries, owing to their very thin protoplasmic walls, have no contractile power, but they permit the passage into the tissues of plasma and leucocytes, and allow of metabolic exchanges taking place. The flow of blood through them depends largely on the state of small arteries and on the venous pressure. In considering the action of drugs on the blood vessels, we have, therefore, to examine their effects either locally or after absorption upon (1) the muscular coat of the vessels, as well as their action on the nerve endings—vaso-constrictors and vaso-dilators and (2) upon the vaso-motor nerve centre in the medulla. Here again, as in the case of the heart, it is difficult to classify drugs on the physiological basis, as we do not know on what set of nerve fibres a drug acts after absorption, and as we cannot definitely say whether it acts on the nerve terminations or on the muscles of the arteries when locally applied. The classification has, therefore, to be made according to the effects they produce on the calibre of the vessels by the stimulation or depression of the muscles in the arterial walls and nerve endings in them.

A. Drugs acting locally on the Blood Vessels either as stimulants or as depressants.

Vascular stimulants or Vaso-dilators are substances which dilate the blood vessels and render the flow of blood through them more rapid. They are used in equalising circulation and preventing the congestion of internal organs. It must be remembered that while cardiac stimulants increase the contractile power of the heart, vascular stimulants diminish the contraction of the vessels and have no action on the vaso-motor centre. They may act by immediate local action when applied to the skin or mucous membrane or by their remote local action when taken by mouth or inhaled.

(*a*) Vaso-dilators acting locally.—Alcohol, Ammonia, Antimony Tartrate, Arsenious Acid, Camphor, Cantharidin, Capsicum, Carbolic acid, Chlorine, Chrysarobin, Copper sulphate (strong), Creosote, Croton Oil, Chloroform, Ether, Iodine, Mercuric Nitrate (strong), Warmth as fomentation or poultice, etc., Volatile oils, Zinc Chloride (strong).

(*b*) Vaso-dilators acting by their remote local action.—Amyl Nitrite (by inhalation), Nitroglycerine, Sodium Nitrite, Spirit of Nitrous Ether, Caffeine, Erythrityl Tetranitrate, Antimony, Belladonna, Hyoscyamus, Stramonium.

Vaso-depressants or Vaso-constrictors are substances which contract the blood vessels and lessen the flow of blood through them. They are chiefly used to lessen inflammation or prevent hæmorrhage. They are, therefore, also called Astringents or Hæmostatics. They may act by their immediate local action when applied to the skin or mucous membrane or they may act by their remote local action on walls of vessels or on the nerve endings after absorption.

Vaso-constrictors acting locally may be classified according to their mode of action :

(*a*) Those lessening the calibre of blood vessels by contracting the muscular fibres in the walls of the vessels, *e.g.*, Adrenaline, Cold in any form, Acetanilide, Phenazonum.

(*b*) Those constricting the vessels indirectly by coagulation of the albuminous fluids around them and its subsequent contraction, *e.g.*, Tannic Acid and all substances containing it, such as Catechu, Krameria, Hammamelis, etc., salts of heavy metals such as Lead, Silver, Zinc, Copper, Iron and Bismuth.

(*c*) Vascular Depressants acting by their remote local action, *e.g.*, Ergot, Digitalis, Adrenaline and Pituitary extract.

B. Drugs acting on the Vaso-motor Centre.—The vaso-motor centre is located in the medulla of the central nervous system. It regulates the flow of blood in the splanchnic area and other parts of the body by exercising a regulative control over the two subordinate centres that bring about dilatation and constriction of the blood vessels. Owing to its location in the central nervous system drugs stimulating or depressing the central nervous system may modify its action. The stimulation of the vaso-motor centre constricts the blood vessels of the splanchnic area without much appreciable effect on the vessels of the skin and muscles. The altered distribution of blood from the splanchnic blood vessels to the peripheral blood vessels causes rise in blood pressure. The depression of the vaso-motor centre dilates the blood vessels of the skin more profoundly than the splanchnic blood vessels with consequent fall in blood pressure and loss of heat. Therapeutically, it is too dangerous to dilate the blood vessels by depressing the medulla and with it the vaso-motor centre.

(*a*) *Drugs stimulating the Vaso-motor Centre.*—Strychnine, Caffeine, Camphor, Ergot, Physostigmine, Turpentine, Digitalis and Squill in small doses.

(*b*) *Drugs depressing the Vaso-motor Centre.*—Alcohol, Ether, Chloroform. These stimulate the vaso-motor centre reflexly for a time and then depress it after absorption. Coal-Tar Antipyretics, Chloral, Hydrocyanic Acid, Opium, Thyroid.

Relation of Cardio-Vascular Activity to Blood Pressure.

By Blood Pressure is meant the pressure which the blood exercises during its circulation on the walls of the arteries. **The rise and fall of blood pressure are dependent on :—**

(1) The quantity of blood in the Vessels.

(2) The output of the heart in a given time.
(3) The resistance of the arteries and capillaries to the flow of blood.

Any alteration' in the activity of these factors, either directly or reflexly through the afferent influences, will modify blood pressure. It is raised by drugs which act as cardiac stimulants or tonics, *i.e.*, by remedies which increase the contractile power of the heart, so as to propel a large amount of blood to the periphery, *e.g.*, Drugs of the digitalis group, or drugs which produce vaso-constriction, so as to cause retention of blood in the arteries, *e.g.*, Adrenaline, Pituitrin and Ergot.

Blood Pressure is lowered by drugs which act as cardiac depressants or remedies which diminish the contractile power of the heart, *e.g.*, Antimony preparations and drugs which produce vaso-dilatation, *e.g.*, Nitrites. The loss of blood or fluids from the body will also cause fall of blood pressure.

The therapeutic indications for increasing blood pressure are manifested in the treatment of shock, either primary or secondary. A severe injury reflexly stimulates the vagus and vaso-motor centres in the medulla and leads to sudden inhibition of the heart and the dilatation of the splanchnic blood vessels; and accumulation of blood in them causes a profound fall in the blood pressure, which is immediately increased by the injection of saline fluid into the blood vessels. In exhausting diseases, there is destruction of tissues and the absorption of their breakdown products acts upon the peripheral blood vessels to dilate them and to produce a condition of secondary shock.

Section V.—DRUGS ACTING ON THE NERVOUS SYSTEM

In studying the pharmacology of drugs acting on the nervous system, according to the present knowledge of their working, we have to separate those that act on the central nervous system from those that act on the autonomic nervous system. The functions of the central nervous system are voluntary while those of the autonomic nervous system are involuntary. Though these two nervous systems carry on distinctive functions in the economy of life, there exists a close relationship between them. Before studying the action of individual drugs on these systems and marking the effects they produce in their functional activity, it is necessary to know the functions they carry out.

Functions of the Central Nervous System.—The voluntary nervous system consists of brain, medulla, spinal cord and the nerves both sensory and motor, that issue from these parts. The convoluted cortical layer of the brain is supposed to be the seat of consciousness. Located in it, are the centres of volitional activity and the psychic centres of the intellect, judgment and reason. The two basal ganglia at the base of the brain, corpus striatum and thalamus, regulate the normal heat of the body. The medulla or the bulb which acts as the connecting link between the spinal cord and the brain contains the centres of many cranial nerves, some of which carry autonomic fibres to the organs of sense. It also contains the centres of reflex functions of the highest importance, such as respiratory, cardiac and vaso-motor. The spinal cord is the organ of conduction and serves as a pathway and intermediate station for impulses travelling along the nerves to and from the brain. It is involved in the performance of various reflex actions and it contains in its sacral part a few autonomic centres controlling the activity of the pelvic viscera. The different parts of the central nervous system not only differ in function but also differ in structure and in the order of evolution. The spinal cord with its reflex functions is the first to be developed in embryonic life, while the brain is developed last. The highly complex functions of the brain are developed as the infant advances in life. It is, therefore, unlikely that the drugs will act with the same uniformity on all parts of the central nervous system. They have a selective action. This selective action may be a stimulant or depressant ; or it may be both stimulant and depressant at one and the same time to the different centres in the medulla, as is seen in opium which acts as a stimulant to the cardiac centre and depressant to the respiratory centre at the same time. A majority of drugs, however, obey the following two general laws while acting on the brain :—

(1) *The Law of Dissolution.*—The drugs for their earliest manifestation of action select the parts and functions of the nervous system in the inverse order of their development. The brain which is the last evolved part of the nervous system and its psychic functions which are last to appear in species are first affected by the action of drugs. The next affected parts are those which are next to the brain and so on until the lowest ones are affected. Finally the functions of circulation and respiration which were acquired first with the birth of the fœtus are affected last.

(2) *The Law of the Primary Stimulation and subsequent depression.*—When a drug in moderate doses excites the functions of the central nervous system, in large doses it depresses that system. The existence of this law is doubted by recent workers and the alternative explanation suggested by them for the primary stimulant effect is that the functions of control and inhibition (will and self-restraint) are depressed from the very start leaving the lower motor centres free to act more actively than normally.

Functions of the Autonomic Nervous System.—The autonomic nervous system with its two component parts, Parasympathetic and Sympathetic, rules over all the involuntary activities of the body such as cardiac, respiratory, vascular, intestinal and secretory. The plain or involuntary muscular fibres of the organs of these activities are innervated by inhibitory (parasympathetic) and acceleratory (sympathetic) nerve fibres. Between this nerve balance these organs unconsciously carry out their functions. When this balance is disturbed by any pathological cause or by the action of drugs the activities of organs supplied by these sets of fibres are either augmented or depressed.

Parasympathetic. Its location and function.—This portion of the autonomic nervous system is closely associated with the central nervous system. It includes fibres lined in the Vagus and also to a lesser extent, in the third, seventh, ninth and eleventh cranial nerves. The sacral portion consists of fibres leaving the cord in the nerve trunks of the second, third and fourth sacral nerves. The fibres passing through the third or oculomotor nerve supply the iris and ciliary muscles of the eye. The fibres passing through the seventh and ninth nerves supply the salivary glands. The tenth or Vagus nerve, the main stay of parasympathetic, supplies fibres to the heart, bronchi, œsophagus, stomach, intestines and pancreas. From the sacral portion through the nervi-erigens are supplied fibres to the descending colon, rectum, anus and genital organs. The effects of the parasympathetic nerve fibres are to contract the pupil, to slow the action of the heart, to increase the functions of the digestive tract, to aid in the passage of the intestinal contents, to stimulate the activity of the intestinal glands, to increase the secretion of pancreas and salivary glands and to cause the contraction of the bladder.

Sympathetic. Its location and functions.—The sympathetic or thoracico-lumbar portion of the autonomic system consists of chains of sympathetic ganglia situated laterally along the vertebral column. These communicate with each other by strands of nerve fibres and are brought into relation with the central nervous system by fibres passing through the sympathetic ganglia of the lateral chains. The sympathetic fibres then pass by way of the spinal nerves to the blood vessels, glands, and abdominal and pelvic viscera. The general effect of the sympathetic is to dilate the pupil, accelerate the action of the heart, increase the blood supply of muscles and cause diminution of blood to the periphery, inhibit the activity of gastro-intestinal tract, decrease the secretions of the salivary glands and relax the sphincters of the anus and bladder.

From the effects of the parasympathetic and sympathetic it would be seen that there exists between them a definite physiological antagonism, so that the preponderance of the one or the other determines the functional activity of the organs of the involuntary musculature.

The precise site of action of the drugs in the involuntary organs is not definitely known. Till recently it was assumed that they acted either on the nerve endings or on the myoneural function, *i.e.*, on the hypothetical receptive substance believed to be interposed between the nerve-endings and the muscles or glands. The researches of Elliot, Loewi, Dale and other workers in the field of pharmacological problems have put forward an entirely different conception on the action of drugs on the autonomic nervous system. According to them, the automatic nerves transmitted their effects to an organ innervated by them by releasing at the nerve-endings specific chemical stimulants which produced their action. In the case of the parasympathetic nerves the substance so released is acetylcholine, and in the case of the sympathetic a substance related to adrenaline, to which the name **sympathin** was given, yet, unlike adrenaline, does not dilate the pupil or relax the uterus, and its action on blood pressure is not similarly reversed by the administration of ergotoxine. In either case the action of the chemical substance is on the organ itself and not on the nerve-endings. The evidence as to the manner in which the nerve impulse, on reaching the nerve-endings, causes the chemical substance to be liberated, is meagre as yet, but the supposition is that it exists in some inactivating and protective complex in the nerve itself from which the nerve impulse releases it and from which it is easily separated by the ordinary method of chemical extraction.

Knowing that the sympathetic fibres have excitory and inhibitory functions, Cannon and his associates postulate probably two forms of Sympathin, namely, **Sympathin E,** which is formed when the action is **excitory** one, and **Sympathin I,** formed when the effect is **inhibitory**. The former is accountable in causing acceleration of the heart, whilst the latter is responsible for the arrest of gut movement or of bronchial spasm.

On this chemical theory of action, the parasympathetic nerves are termed **cholinergic,** while the sympathetic nerves are termed **adrenergic.**

Drugs acting on the Central Nervous System. —These may be classified according to the portion of it which they influence either by stimulating or depressing its function.

A.—Drugs acting on the Cerebrum.

Cerebral Stimulants.—These increase the functional activity of the brain. If the excitement by them is disorderly so as to cause incoherence and delirium, they are called *deliriants*; but if the excitement produces a feeling of mirth and comfort they are called *exhilarants, e.g.*, Belladonna, Stramonium, Hyoscymus, Cannabis Indica, Alcohol, Chloroform, Ether, Nitrous Oxide, Coffee, Tea, Cocaine, Opium, Camphor. Of these the first four act as deliriants.

The cortical cells of the brain are stimulated by Cocaine, Caffeine, Strychnine, Camphor. These agents excite mental activity and in small doses cause wakefulness or increase temporarily the power of mental concentration. In overdoses, Atropine, Camphor and Cocaine lead to delirium. Motor cells of the cortex are stimulated by Atropine and Strychnine and cause clonic convulsions.

Therapeutically cerebral stimulants are of value in many states of depressed mentality and also, as most of them likewise stimulate the lower centres, in shock and other conditions characterised by depression of the vital centres in the medulla. Many of the cerebral stimulants depress the function of the brain after primary stimulation. The drugs acting on the motor cells of the cortex have no therapeutical value in virtue of their power of producing clonic convulsions.

Cerebral Depressants.—These are drugs which lessen or suspend the functional activity of the brain after a preliminary stage of excitement. They are classified into Hypnotics or Soporifics, Narcotics, Analgesics or General Anodynes, and General Anæsthetics.

(*a*) **Hypnotics** or **Soporifics** are drugs which induce sleep closely resembling natural sleep, in which the arteries and veins are both contracted. They may act by directly lessening the excitability and functional activity of the brain cells, without their primary stimulation, *e.g.*, Opium, Morphine, Chloral Hydrate, Butyl-Chloral-Hydrate Chloral-formamide, Bromides, Chloretone, Sulphonal, Paraldehyde, Barbitone, Adaline, Hyoscine, and Warm baths. An abundant meal corduces to sleep by dilating more the vessels of the other parts of the body than of the brain.

(*b*) **Narcotics** are drugs which at first excite and stimulate all body functions, then cause abnormally deep sleep, coma and insensibility; They depress the function of respiration and circulation, *e.g.*, Most of the Hypnotics in larger doses as well as General Anæsthetics, will act as Narcotics. They all tend to induce drug habits, *e.g.*, Alcohol, Canabis Indica, Opium Chloral Hydrate, (*c*) **Analgesics** or **General Anodynes** are drugs which relieve pain by either depressing the sensory centres or by impairing the conductivity of nerve fibres, *e.g.*, Anæsthetics in small doses, Belladonna, Stramonium, Hyoscyamus Opium, Cocaine, Lupulus, Chloral Hydrate, Antipyrine, Amidopyrine, Phenacetin, etc.

(*d*) **General Anæsthetics.**—These are drugs that lead to the total loss of consciousness, and thus abolish pain and reflex action. Anæsthesia is produced either indirectly or directly. Indirect anæsthetic action may be produced by: (1) Cutting off all blood supply to the brain by ligature or compression of the carotid artery or by combined pressure on the carotid arteries and Vagi nerves. (2) Arresting the process of oxidation and tissue change in the nerve cell by increased venosity of the blood as is seen in cases of poisoning by charcoal fumes or carbon-monoxide. (3) Suddenly draining the blood from the head to other parts of the body, as is seen in standing suddenly from the prostrate position. These indirect methods of producing anæsthesia are not used therapeutically; only the drugs having direct action on the nerve cells are used. Most of such drugs are volatile substances, whose vapours, when inhaled sufficiently, cause complete unconsciousness, loss of sensation and motion. These are illustrative of the two general laws regarding the action of drugs on the brain, *e.g.*, Chloroform, Ether, Nitrous Oxide, and other substitution products derived from alcohol and ether.

The Theory of Narcosis.—To explain the narcotic action of general anæsthetics and other narcotic drugs, chloral hydrate and others, which are allyphatic carbons, *i.e.*, hydrocarbons of fatty series, many theories have been put forward. The only theory which is gaining ground and is able to explain a large number of observations connected with narcosis is the " Partition-Co-efficient " theory independently worked out by Meyer and Overton. These observers noted that, almost without exception, the substances which acted as narcotics, sedatives and anæsthetics are more soluble in lipoids—fatlike substances—than in water and their anæsthetic power bore a direct relation to their relative solubility in these media which is spoken of as " Partition-Co-efficient " and is obtained by dividing the solubility of a drug in fat by its solubility in water. Higher the co-efficient, more powerful is the action. These narcotics owing to their solubility in water, enter the circulation rapidly, and are absorbed by the blood. They diffuse through the capillaries and pass out of the blood to the lipoidal tissue, the greatest concentration of which is found in the brain which is rich in blood-supply and lipoidal tissue. This concentration of the drug in the brain penetrates into the nerve cells to disturb the physical condition of the lipoids in it and, by some process yet unknown, destroys its functions and temporarily inhibits the functional activity of the neurons so as to cause narcosis.

B. Drugs acting on the Spinal Cord.—The function of the cord is to conduct impulses—sensory and motor—to and from the brain, to excite reflex action and to originate impulses by the special nerve centres contained in it. The effect of a drug on the spinal cord is usually estimated by the time which elapses between the application of a stimulus and the occurrence of reflex action, before and after the administration of a drug. Longer time indicates diminished, and shorter time increased excitability of the cord. The drugs acting on the reflex mechanism of the cord can be thus divided into :

Spinal Stimulants or *Motor Excitants.*—These stimulate the reflex activity by increasing the irritability of the anterior cornual cells, *e.g.*, Strychnine, Brucine, Ammonia, Thebaine, Chloroform, and Ether in the early stage of their Anæsthesia.

Spinal or *Motor Depressants*.—These depress the reflex activity by depressing the anterior cornual cells, *e.g.*, Bromides, Physostigmine, Ergot, Nitrites, Antimony Salts, Silver Salts, Zinc Salts, Turpentine, and Colchicum.

The following drugs first stimulate slightly and then depress the spinal cord, *e.g.*, Chloral Hydrate, Chloroform, Opium, Ether, Cannabis Indica, Alcohol, Camphor, Carbolic Acid.

The activity of the spinal cord may also be diminished by arresting circulation through it. The drugs acting in such a way are Aconite, Digitalis and Quinine (in large doses).

C. Drugs acting on the Nerves.—The action of drugs on the nerve is studied on its endings where its activity, sensory or motor, is manifested. There are certain drugs which when continued for a long time produce pathological changes in the sensory nerve, so as to cause symptoms of peripheral neuritis which consist, in its stage of irritation, of pain and tingling ; later on as it loses its function, numbness with loss of sensation and paralysis set in often accompanied by trophic lesions. Such drugs are lead, alcohol and mercury. These drugs are of pharmacological interest only and are never given therapeutically to produce that effect. Motor nerve ending in the voluntary muscles may be stimulated to produce spasmodic twitchings as by physostigmine and aconite or they may be paralysed to produce flaccidity and wasting of muscles as by drugs like curare and conium. These drugs, too, are of little importance, for it is never desirable to paralyse the motor nerve endings.

Drugs acting on the peripheral endings of Sensory Nerves (except those of special senses). The peripheral sensory nerve endings may be stimulated to cause pain, or depressed to relieve pain, or paralysed to abolish sensation by local application of drugs. Such drugs are, therefore, classified into local irritants, local anodynes and local anæsthetics.

Local irritants are drugs which dilate the blood vessels of a part to which they are applied and cause pain. They are also called vascular irritants. The intensity of their action depends on the concentration and the time they remain in contact with the part. They are, therefore, further classified as :—

Rubefacients.—These drugs when locally applied to the skin, dilate the superficial blood vessels and cause the skin to become red and warm.

Vesicants are drugs which are sufficiently powerful irritants to cause inflammation of the skin. The inflammation causes exudation of plasma from the blood vessels under the epidermis to form vesicles or blisters, *e.g.*, Cantharidin.

Pustulants are drugs which are not only powerful enough to cause inflammatory processes but also cause leucocytes to permeate the walls of the capillaries, and their collection under the epidermis forms a pustule, *e.g.*, Croton Oil.

Escharotics or *Caustics* are the most powerful of the irritants. They destroy the part to which they are applied and set up vascular dilatation of the surrounding area, *e.g.*, Strong Nitric acid, Zinc Chloride, Silver Nitrate and Arsenious Acid.

Counter-irritants.—The irritant action of drugs is taken advantage of therapeutically, to remove deep seated pain, to subdue inflammation, to help absorption of subcutaneous morbid growths or effusions, to stimulate the central nervous system and to serve a variety of other purposes. They are therefore called counter-irritants. They are applied to the skin, with the idea of stimulating the cutaneous nerves to induce a local, general or special reflex action. Local reflex action is manifested by the dilation of the superficial blood vessels. General reflex action is manifested in the stimulation of medullary centres and special reflex action is manifested by circulatory and trophic changes in the subjacent viscera innervated from the same segment of the spinal cord as the area of the skin irritated.

Local Anodynes are drugs which, when locally applied, relieve pain. In the absence of pain, they remain inert, *e.g.*, Aconite, Carbolic Acid, Menthol, Ether, Alcohol, Chloroform, Chloral, Chloretone, Belladonna, Stramonium, Hyoscyamus, Camphor, Sodium Bicarbonate, Oxide of Zinc.

Besides these drugs, cold is also a powerful depressor of sensibility and therefore it acts as a local anodyne ; so also is warmth which dilates peripheral blood vessels and causes the migration of lymph corpuscles in the surrounding tissues to relieve tension—a great factor in causing pain.

Local Anæsthetics are drugs which abolish the sensibility of the part to which they are applied. They are generally used by subcutaneous injections. They also act as local anodynes, *e.g.*, Cocaine, Benzamine, Amylocaine, Carbolic acid, Urea Hydrochloride, extreme cold whether produced by application of ice or by spraying of Ethyl chloride.

Drugs acting on the Autonomic Nervous System.

THE action of drugs on the autonomic nervous system will be exhibited mainly on the involuntary organs and the glands ; their activity being under the control of double nerve supply, one from the sympathetic and the other from the parasympathetic. The endings of these nerves in them may be stimulated or depressed, to augment or lessen, the activity of involuntary muscles, or to increase or decrease the secretion of glands.

(*a*) *Drugs stimulating the sympathetic nerve endings*, *e.g.*, Adrenaline, Tyramine.

(*b*) *Drugs paralysing the sympathetic nerve endings*, *e.g.*, Ergotoxine ; it, however, stimulates the sympathetic nerve endings in smaller doses.

(*c*) *Drugs stimulating the parasympathetic nerve endings, e.g.*, Pilocarpine, Physostigmine.

(*d*) *Drugs depressing the parasympathetic nerve endings, e.g.*, Atropine, Hyoscine.

Antispasmodics—are drugs which relieve the spasm of muscles by either acting on the nerve centres or on the muscle itself. In the restricted sense, they mean those drugs which relieve the spasm of the bronchial muscles and give relief in cases of asthma. Spasms may occur in voluntary, as well as involuntary, muscles. It generally means sudden irregular contracture of muscles, which is manifested as cramps in voluntary muscles, and colic in the involuntary muscles. It may affect a single muscle or a group, and is generally due to peripheral irritation reflected through the nerve centres. It may be due to the diminished power in the higher co-ordinating centres in the brain over the lower ones, as is manifested in certain diseases as epilepsy.

(*a*) *Drugs acting directly to stimulate the contractions of the involuntary muscles, e.g.*, Barium Salts and Pituitary Extract. Barium Salts, however, are not used therapeutically, as they have a generalised action of stimulating the involuntary muscular fibres wherever they occur. They have no selective action.

(*b*) *Drugs acting directly to relax the involuntary muscular fibres, e.g.*, Nitrites.

A spasm is usually an indication of deficient nervous power. Tonics such as quinine, iron, cod-liver oil, arsenic, cold baths, and moderate exercise are useful adjuvants. Besides these, valerianum, asafetida and other aromatic substances have an antispasmodic action. They possibly act on higher nerve centres so as to increase their regulating power.

Section VI—DRUGS ACTING ON THE EYE

THE drugs acting on the eye are grouped according to *their action on the conjunctiva, pupil, ciliary muscle and on the intraocular tension.*

A. Drugs acting on the Conjunctiva.—The chief drugs employed locally in the treatment of cornea and conjunctiva are **astringents,** such as Silver-nitrate, Alum and soluble salts of Heavy Metals, except lead, and **sedatives** such as Atropine, Opium and Cocaine. The two astringents which are to be avoided are lead and alum. In cases of ulceration on the cornea, they form insoluble albuminate and cause permanent opacity. Alum salts are still more objectionable, in that they dissolve the cement by which the fibrillæ of cornea are held together, and give rise to perforation of cornea whenever epithelium is denuded by inflammation or injury.

B. Drugs acting on the Pupil.—The alteration in the size of the pupillary aperture adjusts the power of accommodation to near or distant vision. This adjustment of the aperture is controlled by contraction and relaxation of the iris which is composed of two sets of muscular fibres, circular which contract the pupil, and radial which dilate the pupil. The circular fibres are innervated by the parasympathetic fibres passing to them through the oculo-motor nerve. The radiating fibres are innervated by fibres from the cervical sympathetic. The centre controlling the contraction of the pupil is located in the corpora quadrigemina. The stimulating of the pupillary centre in the medulla and the parasympathetic fibres in the third nerve cause contraction of the pupil while their paralysation causes dilatation. The stimulating of the sympathetic fibres causes the reverse. If both sets of muscular fibres are stimulated equally at the same time, contraction of the pupil occurs as the circular fibres act at a greater mechanical advantage than the radial. The action of the drugs on the pupil can, therefore, be seen only by the effects they produce in the size of the pupil.

Mydriatics—are drugs which dilate the pupil. They may act by—

(*a*) Paralysing the terminations of the third nerve, *e.g.*, Atropine, Homatropine, Hyoscyamine, Aconite, Amyl Nitrite.

(*b*) Stimulating the terminations of the Sympathetic, *e.g.*, Cocaine, Adrenaline.

(*c*) Paralysing the pupillary centre, *e.g.*, Anæsthetics (late in their action).

Myotics—are drugs which contract the pupil. They may act by—

(*a*) Stimulating the terminations of the third nerve, *e.g.*, Physostigmine, Pilocarpine.

(*b*) Paralysing the fibres of the Sympathetic, *e.g.*, Nicotine.

(*c*) Stimulating the centre for contraction, *e.g.*, Opium and anæsthetics (in early part of their action). Opium makes the pupil pin-pointed.

C. Drugs impairing Accommodation.—Accommodation is the adjustment of the lens to near or distant vision. It depends upon the curvature of the anterior surface of the lens which is regulated by the action of the ciliary muscle which has its nerve supply from the third cranial nerve. The stimulation of the nerve endings in the ciliary muscles contracts the muscle which, by pulling forward the elastic choroid, relaxes the tension on the suspensory ligament and makes the lens more convex and focuses it for near vision, but the paralysation of the nerve endings in the ciliary muscle helps the elastic choroid to pull upon the suspensory ligament and thus render the lens less convex and focuses it for infinity. The following are the main drugs that impair accommodation:—Cocaine, Physostigmine, Pilocarpine. Atropine paralyses accommodation.

D. Drugs affecting the Intra-ocular Tension.—The normal intra-ocular tension depends upon the freedom with which the amount of fluid, poured into the anterior chamber of the eye, passes out into the canal of Schelm located in the angle between the iris and the cornea. The fluid is secreted chiefly by the ciliary body and its passage is retarded or facilitated by the closure or widening, respectively, of the spaces of Fontana. The interference with the normal tension may thus be due (1) to more rapid secretion from the ciliary body; (2) to some obstruction to its outward flow as caused by the dilatation of the pupil which relaxes the iris to press upon and obliterate the canal of Schelm; (3) to the increase in the quantity of blood in the vessels of the eye due to general rise in blood pressure.

(*a*) *Drugs increasing the Intra-ocular Tension.*—Atropine, Hyoscyamine and Homatropine.

(*b*) *Drugs decreasing the Intra-ocular Tension.*—Pilocarpine, Physostigmine and Hyoscine.

E. Drugs affecting the Sensory Apparatus of the Eye.—Strychnine increases the capacity of seeing blue. Santonin causes at first violet and then yellow vision.

F. Drugs acting on the Ocular Muscles.—These are generally the drugs which cause paralysis of the eye muscles. Cocaine causes the eye to protrude.

Section VII.—DRUGS ACTING ON THE URINARY SYSTEM

A. Drugs acting on the Kidneys.—The chief function of the kidney is excretory. It regulates the amount of water in the body under various conditions and removes the products of tissue waste, particularly nitrogenous bodies, formed during the process of tissue metabolism. The structure of the kidney is made up of convoluted tubules lined with two distinct varieties of epithelial cells. The tubules are plentifully supplied with tufts of capillary vessels called glomeruli and with vaso-motor nerves. The glomeruli help the passage of fluid along with the solids, both organic and inorganic, into the lumen of the tubules by the physical process of filtration.

Tubules of the kidneys are assumed to have both excretory and absorptive functions, and from there substances which are of value in the economy of the body are reabsorbed into the system so as to maintain their appropriate level in the blood. Such substances are called "threshold bodies" and they include sugar, sodium, potassium, chlorides, bicarbonates and water. "No-threshold bodies," on the other hand, are waste products of nitrogenous material or other substances of no use to the economy, such as urea, creatinine, foreign substances, and drugs. These are not absorbed at all but are excreted by the tubules as long as they are present in the blood.

The reaction of the fluid becomes acid as a result of excretion by the tubules, of acid salts which are added to the fluid.

The secretion of the kidney is thus greatly modified as regards its quantity and quality by the drugs flowing with the blood into the capillaries of the glomeruli and by their activity on the renal epithelium.

Drugs which increase the quantity of the urine are called *Diuretics* and those which decrease its quantity are called *Anuretics*.

Diuretics are classified according to their action as follows :—

1. *Those acting upon the circulatory system by increasing the arterial pressure either locally or generally*, *e.g.*, Digitalis, Squill, Strophanthus Alcohol, Pituitary extract and Cold to the skin.
2. *Those acting on the kidneys either by irritating the renal cells*, *e.g.*, Volatile oils, Mercury, Cantharidins, or *by increasing the permeability of the*

glomeruli for water and lessening reabsorption in the tubules, *e.g.*, Caffein, Theobromine and Theophyllin.

3. *Those acting by making the blood hydræmic.*—This is effected by drinking a large amount of fluids, by injecting normal saline intravenously, subcutaneously and per rectum, or by administering absorbable salines. These raise the osmotic tension of the plasma by increasing the concentration of blood crystalloids and thus withdrawing water from the tissues to adjust the balance. Blood is thus made hydræmic and increased filtration of water results, *e.g.*, Acetates, Chlorides, Citrates, Nitrates, Sulphates, etc., as well as urea and sugars.

4. *Those acting by causing acidosis, e.g.*, Chlorides of Ammonium and Calcium and Sodium lower the alkali reserve of the plasma and act as diuretics.

Anuretics produce inflammation of the kidney, with consequent venous congestion which prevents its secretion, *e.g.*, Volatile Oils and Cantharidin, when given in toxic doses. These drugs, however, are not used therapeutically as it is never desirable to diminish the quantity of urine.

B. Drugs influencing the Reaction of the Urine :—

(*a*) *Drugs rendering the Urine Acid.*—The alkaline decomposition of the urine in the urinary passage is a fruitful nidus for the growth of bacteria. It is, therefore, absolutely necessary to keep the normal reaction of the urine, which is acid. The drugs mostly used to render urine acid are Benzoic acid and Benzoates, Salicyclic acid and Acid Sodium Phosphate. Benzoic acid and its salts are converted into hippuric acid in their passage through the kidneys. The most reliable drugs as the acidifier of urine is Acid Sodium Phosphate, being a normal constituent of urine.

(*b*) *Drugs rendering the Urine Alkaline.*—Organic salts, such as tartrates, citrates and acetates of alkaline metals, Potassium, Sodium, and Calcium, are oxidised in the body to carbonates and are eliminated as such by the kidneys rendering the urine alkaline. Nitric acid, though a mineral acid, increases the amount of ammonia in the tissues and renders the urine feebly alkaline. Organic Ammonium Salts and Ammonium Carbonate are decomposed in the body and are eliminated as urea and do not render the urine alkaline.

C. Drugs preventing the Growth of Bacteria in the Urine.—The retention of urine in the pelvis of the kidney or in the bladder, from any cause, such as impaction of a stone in the ureter or urethra, or the stricture of the urethra, causes the urine to become alkaline with the admixture of purulent matter resulting from bacterial infection. Drugs that prevent this growth of bacteria are called **urinary antiseptics**. They are all those drugs which turn the urine acid and the following:—Hexamine, Acid Boric, Volatile Oils, Copaiba, Oil of Sandal Wood, Mandelic acid.

D. Drugs altering the Composition of the Urine.—The change in the composition of the urine is brought about by (*a*) the excretion of drugs in their original state, or by (*b*) the excretion of the products of their decomposition, or by (*c*) setting up changes in the body, the products of which are excreted in the urine. They are too numerous to be mentioned here, as almost every drug alters the composition of urine—it being one of the excretory channels for the drugs. The following are the most important :—

Saline Diuretics increase the solids of the urine.

Santonin makes acid urine greenish-yellow, and alkaline urine reddish. Carbolic acid, Creosote, Naphthalene and other tar preparations render the urine dark greenish brown. Picric acid gives it a bright yellow colour, and Methyl-violet a dark blue. Rhubarb, Senna, and Chrysarobin render acid urine yellowish brown, and alkaline urine purplish red.

All Nitrites, Potassium Chlorate, and large doses of Arsenic and mineral acids render the urine dark red from the admixture of the debris of broken up red blood corpuscles.

Cantharidin, Turpentine and Salicylic Acid, all in large doses render the urine bloody. Turpentine, Eucalyptol, impart an odour of violets to the urine while Cubebs and Copaiba convey their characteristic smells to it.

The appearance of albumen in the urine is caused by Cantharidin, Strychnine, Digitalis and large doses of Turpentine.

Many poisons produce Glycosuria: the important ones are Phloridzin or Phloretin and Adrenaline.

The urine of persons poisoned with Carbolic Acid remains sweet for a long time. Lead salts taken for a long time cause chronic interstitial nephritis.

E. Lithontriptics or Antilithics are remedies used to prevent crystallization of solids dissolved in urine and also to dissolve crystals that are already formed. The substances which are most generally deposited are uric acid and oxalate of lime. Uric acid crystallizes out, forming gravel when the reaction of the urine is too acid, while the phosphates and oxalates crystallize out when the reaction of the urine is alkaline. These substances may be deposited in the kidneys or in the bladder, and produce renal or vesical calculus. Alkalies are used to prevent the deposit of uric acid. Benzoic acids and its salts, Hexamine and Acid Sodium Phosphate are used when there is the tendency of phosphatic deposit. Copious draughts of water, by increasing the watery contents of the urine, help to check the formation of crystals.

F. Drugs acting on the Bladder.—The bladder is a receptacle for the accumulation of urine. It is made up of involuntary muscular fibres which expel the accumulated urine by contraction. At the neck of the bladder there is a sphincter which is also made up of the same set of fibres and is supplied by the parasympathetic nerves through the nervi-erigens. When the pressure within the bladder increases beyond normal, a drop of urine escapes into the urethra and acts as a stimulus to the sensory nerves therein, which reflexly causes the inhibition of the sphincter and the contraction of the bladder wall to drive the urine along the urethra. Pathologically, the contraction of the bladder wall may be stimulated by an inflammatory condition of its mucous membrane, caused by the decomposition of the accumulated urine or by the irritation of the calculi formed in the bladder. This irritability of the bladder, which produces constant desire to micturate, may be soothed by drugs acting directly on the nervous system either centrally or peripherally. These are called **Vesical Sedatives,** *e.g.*, Opium, Hyoscyamus, Belladonna. Buchu and Couch grass, act as vesical sedatives probably by diluting the urine and making it less acid and less irritant. Hot water applied externally in the form of a hip-bath is also a useful remedy. The drugs acting as urinary antiseptics will also act as sedatives to the bladder by exerting their antiseptic action on the decomposing urine.

Section VIII.—DRUGS ACTING ON THE SKIN

ONE of the chief specific functions of the skin is to regulate the heat by increasing or decreasing the secretion of sweat, a function which can be attempted by the drugs acting on the blood vessels and on the innumerable sweat glands in it. The drugs acting on the capillaries of the skin and their nerve supply have already been mentioned (see page 99). The sweat glands are independently supplied by the secretory nerves which have their centres scattered in the spinal cord and the medulla. Their nerve-mechanism is independent of the vascular nerves, which regulate the calibre of the blood vessels for increasing or decreasing the secretion of sweat.

Diaphoretics are drugs which increase the secretion of the sweat glands, but when the secretion is in excess, so as to stream down the skin, they are called **Sudorifics.** They may act by—

(*a*) *Directly stimulating the sweat centres in the spinal cord and medulla, e.g.*, Strychnine, Camphor, Ammonium Salts particularly acetate and citrate, Pilocarpine, Opium, Physostigmine. The increased venosity of the blood caused by such drugs as Narcotics in their later stages of action, and the increased temperature of the blood also act by direct stimulation of the sweat centre.

(*b*) *Reflexly stimulating the sweat centres,* by impulses passing to them through the nerves of the mouth, throat or stomach, as is seen in the sweating caused by nauseating drugs, hot drinks, or spiced foods.

(*c*) *Stimulating the terminations of nerves in the sweat glands, e.g.*, Pilocarpine, Physostigmine.

(*d*) *Increasing the cutaneous circulation locally,* as is done by the external application of heat or irritants like Mustard to the skin, or through the vaso-motor centre by internal heat, Alcohol, Salicylates, Amidopyrine, Nauseants, etc.

Anhydrotics are drugs that diminish or check the secretion of sweat. They may act :—

(*a*) *directly or indirectly on the sweat centres by lessening their excitability or removing the excitant, e.g.*, Drugs or measures which reduce the venosity of the blood by strengthening the heart and respiration, such as Ammonia, Alcohol, Strychnine, Iron, Fresh air and Nourishing Food.

(*b*) *by paralysing the terminations of the secretory nerves in the sweat glands*, *e.g.*, Atropine, Belladonna, Stramonium, Hyoscyamine.

(*c*) *by constricting the cutaneous vessels*, *e.g.*, Local application of cold or by sponging the skin by a solution of Sulphuric Acid and water and of Tannin.

(*d*) *by an unknown method of action*, *e.g.*, Acids, Quinine, Zinc Oxide, Nux-vomica.

Drugs altering the composition of Sweat.—Certain drugs are eliminated by sweat, as Iodine, Potassium Iodide, Tartaric, Succinic and Benzoic Acids, the last named in the form of hippuric acid.

Drugs causing a rash to appear on the skin during Elimination.—*E.g.*, Copaiba, Cubebs, Bromides, Iodides, Turpentine, Belladonna, Chloral, Opium, Quinine, Salicylic Acid, Arsenical Salts, Amidopyrine, Phenazonum, Phenacetin, Chloralamide, Antitoxins, Serums, Aconite. Silver salts cause discolouration of the skin.

Emollients or Protectives are **bland or oily** substances applied to the skin to protect it from irritation and to make it more soft and pliable by supplying it with fat or moisture, *e.g.*, Hot Poultices, Warm water, Bland, Oily and Fatty substances, such as Olive Oil, Spermaceti, Petroleum, Vaseline, etc.

Demulcents are substances which soothe and protect the parts. They are generally applied to mucous membranes when they are unduly dry or irritated. They are often used for the mouth, *e.g.*, Glycerine, Linseed, White of egg, Honey, Starch, Gelatin, etc.

Section IX.—DRUGS ACTING ON THE BODILY HEAT

THE constant temperature of the body at 98·4° F. depends upon the maintenance of a proper balance between the amount of heat generated and that given off to the surrounding atmosphere. The heat is chiefly generated in the muscles and glands, and is given off by the skin and lungs though some amount is lost in urine and fæces. The regulation of the body temperature is under the control of a centre situated in the region of the corpus-striatum in the brain. This regulating mechanism is upset in diseases, especially by the bacterial toxins, and there occurs excessive generation of heat without corresponding heat loss. The toxins probably adjust the heat regulating mechanism to the greater production of heat. This pathological generation of heat manifests itself as pyrexia or fever.

A. Antipyretics are drugs which reduce febrile temperature. They have very little action on the normal temperature of the body. These drugs may be divided into two classes: (*a*) Those which lessen the production of heat, and (*b*) Those which increase the loss of heat.

Drugs lessening the production of heat may act by—

(*a*) *Affecting the metabolism through nerve centres*, *e.g.*, Salicin and Salicylic Acid.

(*b*) *Acting on the heat regulating centre in the brain.* They probably adjust the heat regulating centre at a lower level, *e.g.*, Phenacetin, Phenazone and Amidopyrine.

(*c*) *Destroying the poison which raises the temperature*, *e.g.*, Quinine and Arsenic in ague.

Drugs increasing the heat loss may act by—

(*a*) *Dilating the cutaneous vessels and thus augmenting the radiation of heat*, *e.g.*, Alcohol, Antimony, Nitrites, Salicylates, Opium, Aconite.

(*b*) *Increasing the amount of perspiration and causing the loss of heat by evaporation*, *e.g.*, Diaphoretics and Sudorifics internally.

(*c*) *Abstracting the heat from the body*, *e.g.*, Cold Baths, Wet Pack, Evaporating Lotions, etc.

B. Drugs causing a rise of Temperature are Belladonna, Picrotoxin, and Cocaine when given in poisonous doses. Local fomentations, and rubefacients may also raise the temperature of the part to which they are applied. Certain animal poisons, such as Tuberculine and Shell Fish, cause rise of temperature but their *modus operandi* is unknown.

Section X.—DRUGS ACTING ON THE BLOOD

A. Drugs acting on the Plasma.—The composition of the blood consists of the plasma and red and white blood corpuscles. Each of the constituents of the blood carries on a distinctive function in the maintenance of the body for its normal working. The plasma, or Liquor Sanguinis as it is called, is the medium of nutrition, as well as the carrier of the products of metabolic processes. The quality of the plasma can be changed by food, drugs, and transfusion and abstraction of blood. The reaction of the plasma is the most important from a therapeutic point of view. Usually it is faintly alkaline and any change towards acidity rapidly injures or kills the tissues. The tissue of the body is less sensitive to the increased alkalinity of the plasma, because it is constantly producing carbon dioxide which immediately neutralizes the excessive alkalinity, before it produces any deleterious effect on the cells of the body.

In certain diseases, the plasma tends to become acid; but it may be neutralized by drugs such as Carbonates, Citrates, Tartrates, Acetates of alkaline metals, Potassium, Sodium, Magnesium and Calcium. These are oxidised in the body to alkaline carbonates. Ammonia though a fixed alkali is not available to increase the alkalinity of the blood, as it is converted into urea in the blood.

The composition of the plasma could be modified by the abstraction of water and salts. Purgatives, diuretics and diaphoretics drain the body of fluids and thus materially affect the composition of the plasma, while transfusion and directly affect it.

B. Drugs acting on the Red Blood Corpuscles.—These are substances which increase the quality and quantity of red blood corpuscles and consequently of hæmoglobin. They are called *hæmatinics*. They have a pathological significance only as they do not enrich the hæmoglobin in healthy blood. These are divided into two groups—*direct and indirect*. Iron and Arsenic are direct hæmatinics, as they affect the red blood corpuscles by the direct action on them, and their action is much aided by good food, fresh air and attention to general health. Indirect hæmatinics act by benefiting a patient by removing the causative agent of the deficiency of hæmoglobin or anæmia ; such are Mercury given for the cure of syphilis, and Quinine for ague. Diminution in the quantity of red blood corpuscles is caused by the continuous use of certain remedial agents, as Lead and Mercury.

C. Drugs altering the composition of Hæmoglobin.—Hæmoglobin of the red blood corpuscles has the power of absorbing oxygen readily and giving it freely off again. Hæmoglobin combined with oxygen, is called oxy-hæmoglobin. It circulates through the arteries and is deoxidised by the tissues for internal respiration. Hæmoglobin in that reduced condition passes through the veins to form oxy-hæmoglobin again in the lungs. This oxidation and deoxidation of hæmoglobin is interfered with by certain drugs when taken in poisonous doses. They act by—

(*a*) *Reducing the power of hæmoglobin to absorb oxygen* and thus impairing its oxygenating power, *e.g.*, Arsenious Acid, Phosphorus, Sulphur, Oil of Turpentine, Hydrocyanic Acid and Iodine.

(*b*) *Preventing the deoxidation of oxy-hæmoglobin* and thus impairing its oxygenating property, *e.g.*, Alcohol and Quinine.

(*c*) *Converting hæmoglobin into methæmoglobin* which contains only half the oxygen found in oxy-hæmoglobin, *e.g.*, All Nitrites, Potassium Chlorate, Pyrogallic Acid, Antipyrine, Phenacetin and Amidopyrine. These drugs interfere with the tissue respiration and produce a condition of asphyxia. But as soon as the administration of the drug is withheld, the asphyxia disappears, owing to the reducing agents that are constantly present in the blood and the tissues and that accumulate to a greater extent during the process of asphyxia.

(*d*) *Forming new compounds*, such as Carboxyhæmoglobin by inhalation of charcoal fumes, Cyanhæmoglobin by inhalation of Hydrocyanic Acid and Sulphhæmoglobin by inhalation of Sulphuretted Hydrogen.

D. Drugs acting on the White Blood Corpuscles.—The white blood corpuscles or leucocytes have a phagocytic action. They have to migrate through the capillary walls to the seat of lesion, which may be inflammation set up by an irritant or disease. They destroy the poison or get themselves destroyed as seen in the formation of pus in an inflammatory lesion. It then becomes necessary to increase their number or to check their migration into the inflammatory tissue. Their number is increased by Aromatic Oils and Resins, Camphor, Myrrh, Bitters, Pilocarpine. Their migration is effectively controlled by Quinine, Salicylates and Mercury. Their number is decreased by Quinine. Colchicum first diminishes and then increases their number.

E. Drugs affecting the Coagulation of Blood.—It becomes necessary to increase the coagulability of blood in cases of hæmorrhage outside the reach of local medication or when the bleeding is severe. Coagulation of the blood after it is shed is dependent upon the conversion, by thrombokinase and calcium ions, of the prothrombin, liberated from blood platelets, into thrombin, which, interacting with the soluble fibrinogen of the plasma, converts it into insoluble fibrin. The coagulating power of the blood is increased by Calcium

Salts, particularly the Chloride and Lactate, Milk, Carbon dioxide, and normal Horse Serum. It is decreased by Oxygen, Alcohol, Citric Acid, Bile and large quantity of fluids.

Section XI.—DRUGS ACTING ON THE ORGANISMS INFESTING THE HUMAN BODY

MANY organisms in the form of moulds, bacteria and parasites, infest the human body. Moulds and fungi cause some local disease, especially on the skin. Bacteria are every day becoming more and more important on account of the relation they bear to various diseases. They enter the body and affect the various organs. Moulds and fungi are living organisms which, in the course of their life processes, cause decomposition of substances in which they live. They produce pathogenic changes and it becomes necessary, by physical agents or chemical substances, to arrest their fermentative processes, either by inhibiting their growth or by completely destroying them.

Antizymotics are substances which arrest fermentation. They are divided into antiseptics and disinfectants or germicides.

Antiseptics are substances which inhibit the growth of micro-organisms on which septic decomposition depends.

Disinfectants or **Germicides** are substances which kill the micro-organisms of communicable diseases.

Most of the antiseptics in strong concentration act as germicides while most of the germicides in weaker concentration act as antiseptics. The activity of antiseptics or disinfectants is greatly modified by—

1. The temperature at which they act; at higher temperature, their antiseptic value is greatly increased.
2. The medium in which they act. Some of the antiseptics act powerfully in a watery solution. Many lose much of their power in oil or glycerine or in the presence of protein or serum.

3. The strength of the solution. The more concentrated the solution is, the more powerful is its action ; but concentration must be such as will not injure the tissue.
4. The length of time allowed for the disinfectant to act. The longer the time they remain in contact, the more certain is their action.
5. The quantity of organism present in the substance to which they are added.

An ideal antiseptic or disinfectant must have a maximum action on the micro-organism and minimum action on the tissue. It must not produce local toxic effects on the tissues, or general poisoning, and it should not lose much of its activity in the presence of organic matter. It must be soluble in water and rapid in its action. A solution must not stain the skin or clothing or instruments. It must be non-volatile so as to give a prolonged action, and it must have the power of penetration into the deeper layers to disinfect the ducts of the sweat glands. An ideal antiseptic is not yet found, but the flavine compounds have the nearest approach to it.

Antiseptic action is produced by drugs in one or the other of the following ways (Dixon) :—

1. **By Salt Action.**—They act by osmosis, by extracting water from the organism and killing them, *e.g.*, Common Salt (used for preserving meat and fish) ; Sugar (for preserving fruits).
2. **By Oxidation.**—Certain substances give off free oxygen, as soon as they are brought into contact with the tissues. The oxygen liberated tends to oxidise its surroundings. These are useful antiseptics to anærobic micro-organisms which cannot flourish in the presence of oxygen, *e.g.*, Hydrogen Peroxide, Potassium Chlorate—Permanganate—Bichromate, Boric Acid, Hallogen

group (Chlorine, Bromine and Iodine). The last named acts in the presence of water by liberating oxygen.

3, **Reduction.**—Some substances owe their antiseptic action to the liberation of hydrogen in the presence of which no ærobic organism can flourish, *e.g.*, Sulphur dioxide in the presence of water.

4. **Precipitation of Proteins.**—Certain antiseptics combine with the albuminous bodies surrounding the bacteria and thus deprive the organism of the source of nourishment, *e.g.*, heavy metals, such as Mercury and Zinc.

5. **Acting as general protoplasmic poisons.**—These act directly on the micro-organisms to kill them, but with the disadvantage that the concentration necessary to kill the micro-organism may also, at the same time, poison the tissues of the body.

The number of antiseptics and disinfectants is too numerous to be mentioned ; and since the destruction of micro-organism is required under different conditions, a suitable antiseptic must be selected for each particular purpose. The following is the list of antiseptics arranged according to the purpose for which they are used :—

I. SURGICAL ANTISEPTICS, *e.g.*, Carbolic Acid, Cresols, Lysol, Acriflavine and other antiseptics of the Coal-Tar group ; Mercuric Chloride, Zinc Chloride and Sulphate and other metallic disinfectants. Hydrogen Peroxide, Potassium Chlorate—Permanganate—Bichromate and other oxidising disinfectants. Hypochlorite Solution and other Chlorine preparations. Iodine, Iodoform, Boracic Acid and Borax.

II. ANTISEPTICS USED CHIEFLY IN SKIN DISEASES, *e.g.*, Chrysarobin, Naphthol, Resorcin, Tar, Balsams, etc.

III. INTESTINAL ANTISEPTICS, *e.g.*, Beta-Naphthol and other intestinal disinfectants.

IV. GENITO-URINARY ANTISEPTICS, *e.g.*, Volatile oils, Hexamine, Salicylic and Benzoic Acids and other acidifiers of urine.

V. PULMONARY ANTISEPTICS, *e.g.*, Creosote, Guaiacol and Volatile oils.

VI. DISINFECTANTS FOR ROOMS, furniture, etc., *e.g.*, Heat, Formaldehyde, Sulphur dioxide, Chlorine and Bromine vapours, etc.

Deodorizers or Deodorants are substances which destroy the disagreeable smells accompanying the decomposition of various organic substances infected with septic micro-organisms. All antiseptics act as deodorizers.

Antiparasitics are substances which destroy the parasites that infest the skin and its appendages. The parasites infesting the skin are the various forms of tinea, itch and pediculi which reside in the hairy parts of the skin. Mercurial preparations, Tincture of Iodine, Carbolic Acid, Formaldehyde, and Chrysarobin, kill the various tinea. Balsams-Peru, Tolu, and Storax, and Sulphur destroy the parasite of itch. Mercurial preparations destroy pediculi.

Antiperiodics are drugs which prevent the return of diseases which occur periodically, such as malarial fevers and neuralgias. They act by destroying the organism causing the disease, *e.g.*, Cinchona bark and its alkaloid Quinine, Arsenic, Salicylic Acid, Salicin and Eucalyptus.

Section XII.—DRUGS ACTING ON THE ORGANS OF GENERATION

THE sexual functions are regulated by nerve centres in the brain and spinal cord. In the higher centres is the seat of passion which prompts an individual to seek a sexual congress while the lower centres in the lumbar region of the spinal cord regulate, through the nervi-erigens, the condition of erection, which is partly due to the dilatation of the arteries and partly to the compression of the afferent veins of the penis. These nerves may act independently of each other, but interrelation exists in that one may react on the other. Both these centres may also be stimulated reflexly: the spinal centre by the stimulation of the sensory nerves of the adjoining parts or by psychical stimuli transmitted to it from the brain; the Cerebral centre by impressions made on the sensory nerves of the spine or the nerves supplying the organs of sense such as eye, ear, nose and the general surface of the body.

A. Aphrodisiacs are drugs which increase sexual desire. They may act directly or indirectly.

(a) *Direct Aphrodisiacs* act through nerve mechanism, *e.g.*, Strychnine, Cantharidin, Alcohol, Cannabis Indica, Camphor, Phosphorus, Damania.

(b) *Indirect Aphrodisiacs* act by improving the general nutrition of the body, *e.g.*, All those drugs which excite hunger and improve the quality and quantity of blood and those that act as tonic.

Anaphrodisiacs are drugs which diminish sexual appetite. They may act by—

(a) *Lessening the excitability of local nerves, e.g.*, Application of ice, Cold bath and Bromides.

(b) *Depressing the nerve centres, e.g.*, Bromides in large doses, Iodides, Opium, Belladonna, Hyoscyamus, Stramonium, Digitalis.

(c) *Removing the cause of reflex-action, e.g.*, Alkalies in case of acid urine, Purgatives in case of constipation.

B. Ecbolics or Oxytocics are drugs which cause contraction of the gravid uterus and thus aid the expulsion of its contents. They may act by—

(*a*) *Direct action on the muscular fibres of the Uterus*, *e.g.*, Lead, Quinine, Histamine and Pituitary extract.

(*b*) *Stimulating the motor sympathetic endings*, *e.g.*, Ergot, Ergotoxine, Adrenaline, Pilocarpine.

(*c*) *Indirectly causing congestion of the pelvis viscera*, *e.g.*, Drastic Purgatives, Aloes, and other irritants like Turpentine Cantharidin.

C. **Emmenagogues** are drugs which restore and regulate the menstrual flow. They may act :—

(*a*) *Directly by stimulating the non-gravid uterus and increasing the menstrual flow*, *e.g.*, All Ecbolics, Asafetida, Myrrh, Cantharidin, Borax, etc.

(*b*) *Indirectly by improving the quality of blood*, *e.g.*, Iron, Manganese.

(*c*) *By improving the tone of the nervous system*, *e.g.*, Strychnine, Nux-vomica.

(*d*) *By increasing the vascularity of the uterus*, *e.g.*, hot hip-bath, and mustard bath to the legs.

(*e*) *By causing congestion of the pelvic viscera*, *e.g.*, Aloes, Drastic Purgatives.

Uterine Sedatives are drugs which restrain the contractions of the gravid uterus, *e.g.*, Opium, Chloral, Chloroform, Bromides, Viburnum Prunifoleum. These act chiefly through the nerve mechanism.

D. **Galactagogues** are drugs which increase the secretion of milk, *e.g.*, Pituitary extract, Pilocarpine, Alcohol, Leaves of Castor Oil Plant, and Tonics improving general health.

Antigalactagogues are drugs which decrease the secretion of milk, *e.g.*, Belladonna, Camphor and Iodides,

PART III

INORGANIC MATERIA MEDICA

GROUP I

THE ALKALINE METALS

Potassium, Sodium, Ammonium

General Characteristics.—The compounds of these alkalimetals, with the exception of Ammonium, are akin to one another in their pharmacological action. They all neutralise acids, saponify fats and combine with albumen to form a soluble alkali albuminate. This action is termed alkaline action. They are all powerful bases and have a great affinity to water. The therapeutic actions of their salts are attributable to their anions (acid radicals).

POTASSIUM

Though Potassium is an important constituent of the body, yet therapeutically the action of the potassium ion is never desired for the reason that it powerfully depresses all the nerve and muscle tissues. The compounds of potassium are used in medicine for the actions of the other ions associated with it. When taken by mouth, even in large quantities, these compounds rapidly disappear from the blood, being deposited in the tissues from which they are gradually removed and excreted by the kidney and bowels. When potassium salts are injected hypodermically or intravenously, the toxic effects of the potassium ion are manifested.

1. Potassii Hydroxidum.—Caustic Potash. *Synonym.*—Potassa Caustica ; occurs in white deliquescent sticks which when exposed to air, readily absorb carbon dioxide and water and liquefy. It is freely soluble in water and contains 85 per cent. of total alkali as potassium hydroxide.

> **Liquor Potassii Hydroxidi.**—Solution of caustic Potash contains 5 per cent. caustic potash in water. The solution is strongly alkaline, and is kept in green glass bottles with air-tight stoppers. It is used in the preparation of Liquor Arsenicalis.

Dose—10 to 30 m.—0·6 to 0·18 mils. (freely diluted).

Incompatibles.—Acids and acid salts, alkaloids as they are precipitated by alkalies and preparations of Belladonna, Hyoscyamus and Stramonium as the alkaloids of these are decomposed by caustic potash.

2. Potassii Carbonas.—Potassium Carbonate. *Synonym.*—Salt of Tartar. A white granular hygroscopic powder with a strongly alkaline reaction. Soluble in its own weight of water. Contains not less than 99 per cent. of pure potassium carbonate calculated on the salt dried between 200 to 300° F.

Dose—2 to 5 grs.—0·12 to 0·3 G.

3. Potassii Bicarbonas.—Potassium Bicarbonates. A white granular powder or colourless crystals, soluble in 4 parts of water; almost insoluble in alcohol (90 per cent.); taste saline and feebly alkaline.

Dose—15 to 60 grs.—1 to 4 G.

ACTION OF THE ALKALINE SALTS OF POTASSIUM

External.—Potassium Hydroxide in concentrated solution acts as an **irritant** and as a **caustic** by extracting water from the cells. It is liable to penetrate deeply and cause ulceration as the tissues being alkaline cannot limit its action. Potassium Carbonate has very nearly the same action, but it is less powerful; while potassium bicarbonate is the most feeble in action as a caustic. These salts neutralize acids, dissolve fatty matter and act as cleansing agents. They are **antacids**, and if freely diluted they act as **sedatives**,

Internal.—*Alimentary Tract.*— In the mouth, alkalies have a soapy taste, and in concentrated solutions they irritate the mucous membrane of the mouth. In the stomach, when given before meals, alkalies do not materially affect the secretion of gastric juice, but the carbonate and bicarbonate owing to the liberation of carbonic acid, increase the flow of gastric juice. They dissolve the excessive mucous and act as sedatives to the nerves of the stomach. Given after meals, they act as **antacid** by neutralizing the gastric juice already secreted, and in large quantity they may interfere with peptic digestion by rendering the gastric contents alkaline. The alkaline chyle reaching the intestines, retards the pancreatic secretion, which is normally stimulated by the highly acid fluid from the stomach. The intestines are not directly affected by the alkaline salts nor are the liver and the bile.

Blood.—All alkalies circulate in the blood principally as bicarbonates. They increase the alkali contents of the plasma, but since potassium is rapidly excreted, the effect is transitory. They are supposed to increase the amount of hæmoglobin, if deficient. They are, therefore, used as adjuvants to iron in the treatment of anæmia. Their prolonged administration, however, causes the quality of blood to deteriorate and reduces the body weight.

Circulatory System.—In therapeutic doses the salts of alkali metals have no action on the heart. In large doses, or when given by intravenous injections, they act as depressant to all muscular tissue and thus decrease the force of the heart, causing a fall in blood pressure and in the pulse rate.

Respiratory System.—These act as saline **expectorants** and stimulate the secretion of bronchial mucous and render it less viscid and adherent.

Metabolism.—Potassium salts increase metabolism and cause greater oxidation of proteins and fats; consequently they increase the excretion of urea and other solids in the urine.

Urinary System.—The alkaline salts of potash act as saline **Diuretics.** The carbonates, bicarbonates and the vegetable salts of Potash circulate in the blood as carbonates and increase its osmotic tension. This prevents the normal passage of the fluid from the blood to the tissues, but favours the passage of the fluid from the tissues to the blood. The blood, in consequence, becomes hydræmic and reaching the glomeruli of the kidneys, salts and water filter out in the tubules to promote diuresis. They render the urine alkaline and thus increase the solubility of uric acid, but as solvents of uric acid, they must be administered in large doses. The alkalinity of the urine soothes any irritation on the genito-urinary tract, and inhibits the growth of Bacillus Coli.

Muscles and Nerves.—Potassium ion acts as a depressant to the muscular and nervous tissue; but being rapidly excreted, it is never accumulated in the system sufficiently to cause any untoward effect, unless its salts are given in enormously large doses.

4. Potassii Acetas.—Potassium Acetate. White foliaceous, deliquescent, satiny masses or granular particles with a sharp, saline taste; soluble in 0·5 part of water.

Dose—15 to 60 grs.—1 to 4 G.

5. Potassii Citras.—Potassium Citrate. A white granular deliquescent powder freely soluble in water with a saline taste.

Dose—15 to 60 grs.—1 to 5 G.

ACTION OF POTASSIUM ACETATE AND CITRATE

External.—They have no action, being neutral in reaction.

Internal.—Being neutral salts, they have no action on the secretion of the stomach and intestines. After absorption they are converted into carbonates and exert specific action on the renal tubules and act as **diuretics.** They are eliminated as carbonates in their passage to the kidneys, and they render the urine alkaline. They act as mild **diaphoretics,** especially the citrate. How they produce this effect is not known. These salts, like the carbonates and bicarbonates, increase the secretion of the bronchial mucous membrane and act as mild **expectorants.**

6. Potassii Tartras Acidus.—Acid Potassium Tartrate. *Synonyms.*—Bitartrate of Potash ; Cream of Tartar. A white crystalline powder with a pleasant acid taste, soluble in 200 parts of water.

Dose—15 to 60 grs.—1 to 4 G.

It is contained in Confectio Sulphuris, Pulvis Jalap Compositus.

Action of Potassium Acid Tartrate

External.—None.

Internal.—This salt, owing to its tardy absorption, acts as a saline **purgative** (see page 71). It acts by stimulating the glandular secretion of the intestines and by preventing its absorption. The citrates and tartrates while stimulating the secretion of the intestines, get absorbed into the system as carbonates, which stimulate directly the renal epithelium, and thus act as **diuretics** rendering the urine alkaline.

7. Potassii Nitras.—Potassium Nitrate. *Synonyms.*—Nitre ; Saltpetre. Occurs in white crystalline masses or in six sided, colourless prisms, soluble in 4 parts of water.

Dose—5 to 15 grs.—0·3 to 1 G.

It is contained in Argenti Nitras Induratus.

Action of Potassium Nitrate

External.—It is a local **refrigerant.**

Internal.—*Alimentary Tract.*—Potassium Nitrate, unless given well diluted, is liable to irritate the stomach, producing nausea, vomiting and diarrhœa.

Absorption and Elimination.—It is entirely absorbed from the intestines, and circulates in the blood unchanged. A part of it is excreted as such in the urine and the remainder undergoes some change in the body, the nature of which is not known.

Circulatory System.—In medicinal doses, it has no appreciable action on the heart. In **large doses** it acts as a **cardiac depressant,** and renders the action of the heart slower and weaker than usual.

Skin and Kidneys.—Potassium Nitrate is both **diaphoretic** and **diuretic.** It is more powerful than most of the other alkaline salts, probably owing to the slight irritation of the kidneys caused by it, for Potassium has a low renal threshold and nitrate is foreign to the tissues.

Respiratory System.—Fumes of Nitre, when inhaled, act as a respiratory sedative and **antispasmodic,** the nitrate being converted into nitrite during combustion.

8. Potassii Chloras.—Potassium Chlorate. It is a colourless lustrous granular powder, soluble in 16 parts of water.

Incompatibles.—It easily explodes in trituration with organic substances or with Charcoal, Sulphur, Sulphides, Hypophosphites or other easily oxidisable substances.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION OF POTASSIUM CHLORATE

External.—It was once used as an antiseptic acting by virtue of its oxidising power within the organism. This assumption has proved to be erroneous, for, in solution and at ordinary temperature, it scarcely oxidises organic substances.

Internal.—In dilute solution potassium chlorate exerts a cooling, **sedative** and **disinfective** influence in the mouth and throat. In medicinal doses, it has no action on the secretions of the stomach and intestine, nor has it any action on the circulatory, respiratory or nervous systems. Its main action is on the blood and that too when given in large doses. It disintegrates the red blood corpuscles, and converts hæmoglobin into **methæmoglobin,** which gives off no oxygen for the tissues. This interferes with internal respiration and produces a condition of asphyxia; which asphyxiated condition affects the heart and respiration secondarily. Liver and spleen are engorged with disintegrated red blood corpuscles; and there may be jaundice and hæmatemesis.

Kidneys.—In small doses, it acts as a **diuretic.** In large doses, the kidneys become congested, and the disintegrated corpuscles block the renal tubules and induce inflammatory changes. The urine becomes scanty and contains albumen, casts and debris of broken red blood corpuscles. Later on there occurs suppression of the urine and death from cardiac weakness and uræmia.

Excretion.—Chlorates are absorbed unchanged from the stomach and other mucous surfaces and excreted unchanged chiefly in the urine. They are also excreted by milk, sweat, saliva and the bronchial mucous membrane.

9. **Potassii Bromidum,** see Bromine.
10. **Potassii Iodidum,** see Iodine.
11. **Potassii Oleate** (Sapo-Mollis), see Olive Oil.
12. **Potassii Permanganas,** see Manganese.
13. **Potassii Sulphurata,** see Sulphur.

THERAPEUTIC USES OF POTASSIUM SALTS

Potassium Hydroxide is used as a caustic to destroy warts, condylomata, lupus and other morbid growths. Liquor Potash is employed as a mild caustic and antacid. It is also employed to soften an ingrowing toe nail before removal. In a dilute form it is used to cleanse the skin and relieve itching.

The Bicarbonate of Potash is employed in dyspepsia, when the gastric juice is deficient and after food when there is pain at the epigastrium, heart burn or acid eructations. It is also used as an injection for discharge from mucous surfaces (leucorrhœa, etc.), as an application to rheumatic joints, and as a lotion in various skin diseases. Salts of Potash are given internally in acute or chronic rheumatism or in gout, either as diuretics or as saline purgatives. The Acid Tartrate is generally given as a purgative in the form of Pulvis Jalap Compositus. It is also used to make cooling drinks for feverish patients in the form of Imperial Drink which contains Acid Potassium Tartrate 60 grains; Saccharin 1 grain and oil of Lemon 3 minims to a pint of boiling water. Potassium Citrate and Bicarbonate are good diuretics in heart disease and in chronic kidney affections. The Nitrate of Potash acts as a diuretic and diaphoretic and is employed on ignition for asthmatic spasms. The Chlorate of Potash is used as gargles or given internally in sore throat, in ulceration of the mouth and in mercurial salivation. It has also been given to women liable to miscarry.

SODIUM

The Sodium ion, like Potassium ion, has no physiological action. Sodium salts act by salt action or by the action of their other ions. They can conveniently be divided into two groups according to their action. (1) Antacids :—Sodii Carbonas and Bicarbonas. (2) Purgatives :—Sodii et Potassii Tartras, Sodii Phosphas and Sodii Sulphas and their preparations.

1. **Sodii Hydroxidi.**—Caustic Soda. It occurs in white sticks or fused masses, which when exposed to air readily absorb carbon dioxide and water. It is freely soluble in water and contains 95 per cent. of the total alkali calculated as Sodium Hydroxide. It should be kept in a well closed container.

Liquor Sodii Hydroxidi.—Solution of sodium hydroxide. It contains about 4 per cent. of total alkali.

2. **Sodii Carbonas.**—Sodium Carbonate. *Synonym.*—Washing Soda, or Soda. Large, colourless, efflorescent crystals

with a strongly alkaline reaction and soluble in 2 parts of water.

Dose—5 to 15 grs.—0·3 to 1 G.

3. **Sodii Carbonas Exsiccatus.**—Exsiccated Sodium Carbonate almost devoid of water. It is a dry white powder containing 99·5 per cent. of pure salt.

Dose—2 to 5 grs.—0·12 to 0·3 G.

It is contained in Pillula Ferri Carbonatis and forms carbonate of Iron.

4. **Sodii Bicarbonas.**—Sodium Bicarbonate, a white powder with a cool, mildly alkaline taste, soluble in 11 parts of water.

Incompatibles.—Acids and Acid Salts. (These liberate carbon dioxide) and alkaloids. (These are precipitated.)

Dose—15 to 60 grs.—1 to 4 G.

ACTIONS OF SODIUM CARBONATE, BICARBONATE AND EXSICCATED SODIUM CARBONATE

The alkaline salts of sodium have the same action as the alkaline salts of potash. They are less caustic and are largely used. They are not depressant to the cardiac, muscular and nervous systems. They are more slowly absorbed than the corresponding salts of potash, and after absorption their action is the same.

5. **Sodii Phosphas.**—Sodium Phosphate; colourless crystals with a weak alkaline reaction; soluble in 7 parts of water.

Dose—30 to 240 grs.—2 to 16 G. for repeated administration.
¼ to ½ oz.—8 to 16 G. for single administration.

6. **Sodii Phosphas Effervescens.**—Effervescing sodium Phosphate; granular dehydrated mass made by mixing sodium phosphate with sodium bicarbonate, citric and tartaric Acids.

Dose—60 to 240 grs.—4 to 16 G. for repeated administration.
¼ to ½ oz.—8 to 16 G. for single administration

7. **Sodii Sulphas.**—Sodium Sulphate. *Synonyms.*—Glauber's Salt. Transparent, efflorescent crystals, soluble in 3 parts of water. Neutral in reaction, with saline taste.

Dose—30 to 240 grs.—2 to 16 G. for repeated administration.

¼ to ½ oz.—8 to 16 G. for single administration.

Sodii Sulphas Exsiccatus. *Synonyms.*—Anhydrous sodium sulphate, Exsiccated Glauber's salt. A white, hygroscopic powder with bitter and saline taste. It is soluble in 8 parts of water

Dose—15 to 120 grs.—1 to 8 G.

8. **Sodii Sulphas Effervescens.**—Effervescing Sodium sulphate, granular dehydrated mass made by mixing sodium sulphate with sodium bicarbonate, citric and tartaric Acids.

Dose—60 to 240 grs.—4 to 16 G. for repeated administration.

¼ to ½ oz.—8 to 16 G. for single administration.

9. **Sodii et Potassii Tartras.**—Sodium Potassium Tartrate. *Synonym.*—Rochelle Salt, colourless crystals or white crystalline powder, with a cool saline taste ; freely soluble in water.

Dose—120 to 240 grs.—8 to 16 G.

Pulvis Effervescens Compositus. *Synonyms.*—Pulvis Sodæ Tartratæ Effervescens ; Seidlitz Powder. It is made up in 2 powders, Rochelle Salt and Sodium Bicarbonate, wrapped in blue paper, Tartaric Acid wrapped in white paper. The powder in the blue paper is dissolved in nearly half a pint of water, either cold or warm, and that in the white paper is then added, either dry or dissolved. This solution has the refreshing taste of CO_2.

Dose—1 set of powders.

ACTION AND THERAPEUTIC USES OF SODIUM PHOSPHATE, SULPHATE AND TARTRATE

These salts, owing to the tardy absorption of their anion phosphate, sulphate, citrate and tartrate, pass through the intestine unabsorbed, acting as typical **saline purgatives.** They disturb osmotic balance between the contents of the bowels and the surrounding tissues. The low diffusibility of the sodium salts impede the absorption of fluids so that between the stimulated secretion on the one hand, and the impeded absorption on the other, there is accumulation of fluid in the canal. This increased bulk of the fluid distends the canal and excites peristaltic action. The fluid then wends its way along the intestine, softening the scybalous masses, until it reaches the rectum and produces soft and easy purgation. The **sulphate** is an active **purgative**, and the **phosphate** is a **cholagogue.** These salts do not enter the circulation quickly, and hence as alkalizers of the urine they have a feeble action and are less efficient as diuretics. These drugs are useful to remove fluid in cases of dropsy; and they are best administered in lukewarm water in successive small draughts in the morning before breaking fast. A walk is advised between the drinking of the last portion and the partaking of the first meal. This is to assist the passage of the solution to the intestine. Hourly doses of saturated solution of sodium sulphate are excellent for bacillary dysentery.

10. Sodii Chloridum.—Sodium Chloride. *Synonym.*—Common Salt; transparent cubic crystals, or a white crystalline powder, soluble in 3 parts of water.

1. Injectio Sodii Chloridi et Acaciæ.—It is a sterile, faintly yellow and opalescent solution containing 0·9 per cent. of Sodium Chloride and 6 per cent. Acacia in distilled water.

2. Liquor Sodii Chloridi Physiologicus.—Physiological solution of Sodium Chloride, *Synonym.*—Normal Saline Solution. It is a freshly prepared sterile solution containing 0·9 per cent. of Sodium Chloride in Distilled Water.

ACTION OF SODIUM CHLORIDE

Sodium Chloride is an essential constituent of the body, present in a constant amount in the blood and tissues. As an article of dietary, it is consumed in large quantity. It, however, acts as an indifferent salt in the body, as neither of its ions produces any physiological action; but if given in concentrated doses, its action varies in proportion to the concentration of the salt in the solution, and it influences the passage of fluids into, or out of, the cells and thus exerts its peculiar salt action which is due to the physical phenomena of osmosis. If the two saline solutions of different molecular contents are separated only by a semipermeable membrane, water is attracted from the solution of low concentration into the solution of higher concentration. This process goes on until the two solutions are equi-molecular and then it ceases. Solutions having the same osmotic pressure are called isotonic, and osmotic pressure is the force with which the salt holds the water. If one of the solutions is of higher concentration than the other, it is called hypertonic, and the other which is of lower concentration is called hypotonic. These osmotic currents continuously go on to preserve the osmotic balance in the body, through the epithelial cells of the mucous membrane and the endothelial cells of the capillaries which act as semipermeable membranes.

External.—The physiological salt Solution, which is sometimes called " Normal Saline Solution " contains 0·9 per cent. of salt, and is isotonic with blood. Such a solution of salt is sedative and protective to the abraided and inflamed surfaces. Applied to the bleeding surface, it acts as a hæmostatic. Hypotonic solutions are non-irritating to the mucous surfaces, but they cause the swelling and softening of the superficial layers. Hypertonic solutions are irritating to the sensitive mucous membranes of the nose and eyes and cause sneezing and lacrymation.

Internal.—*Alimentary Tract.*—Sodium chloride has a characteristically salty taste, and in **strong solution** acts as an **astringent.** It **reflexly increases the secretion of saliva,** which is soon followed by dryness of the mouth and thirst, owing to the abstraction of water from the mucous membranes. In the stomach, in small doses, it acts as a **stomachic.** Large doses are irritant and interfere with gastric digestion. In concentrated solution, it acts as an **emetic.** The isotonic solution when taken in large quantities, acts as a mild laxative. It acts as an **anthelmintic** when rectally administered.

Absorption and Elimination.—Sodium chloride is absorbed from all abraided and mucous surfaces. From the stomach and intestine, it is absorbed quite readily. The concentrated solution, however, is absorbed only when it becomes isotonic with the blood. By injection into the subcutaneous tissues, it is absorbed more quickly. Sodium chloride is excreted by all secretions and excretions of the body, but the greater part appears in the urine, sweat and saliva.

Blood and Lymph.—Sodium chloride enters the blood stream in an isotonic solution. The effects of such a solution are dependent on the bulk absorbed and not on the presence of sodium chloride. The injection of large quantities of isotonic solution into the blood stream does not change the osmotic pressure in the tissues and it is not rapidly eliminated. It, therefore, infiltrates into loose subcutaneous tissues, which become swollen and œdematous. If the solution used is hypertonic, lymph is drawn into the blood from the tissues by osmotic attraction and the increased volume of blood causes pressure in the capillaries to rise, which in its turn induces the flow of lymph from the blood vessels into the surrounding lymph spaces. This interchange between blood and lymph is kept by variations in the osmotic pressure between them due to the increased activity of the excretory organs which remove all superfluous salt solution in the blood by rapid diuresis and sweating.

11. Sodii Phosphas Acidus.—Acid Sodium Phosphate. *Synonym.*—Sodium Di-hydrogen Phosphate; transparent colourless crystals with acid reaction and readily soluble in water.

Dose—30 to 60 grs.—2 to 4 G.

ACTION AND THERAPEUTIC USES OF ACID SODIUM PHOSPHATE

Being the natural acid of the urine, it is largely used to render alkaline urine acid in order to check the growth of some of the micro-organisms. It thus acts as a urinary

antiseptic. It is also used when hexamine is being given. It is only in the acid medium that hexamine liberates formaldehyde to which its antiseptic action is due.

12. Sodii Citras.—Sodium Citrate. It occurs in slightly deliquescent granular crystals or crystalline powder; odourless and saline in taste. It is soluble in less than 2 parts of water.

Dose—15 to 60 grs.—1 to 4 G.

Action and Therapeutic Uses of Sodium Citrate

Administered by the mouth, the acid of the salt is digested and destroyed, liberating the base, which acts as an alkali inducing diuresis, and lessening the acidity of urine. Given by injections, Sodium Citrate combines with the Calcium of the serum and forms non-ionizable double salts with it. This leads to the loss of the clotting power of blood and in large doses leads to tetany, convulsions and cardiac failure—the results of calcium deprivation. Added to drawn blood in 0·2 per cent. solution, it retards or prevents coagulation. This property of the salt makes it useful to render blood, intended for transfusion, incoagulable. It is added to the milk for infant feeding, to form calcium citrate, which renders the curds soft, flocculent and digestible.

13. Sodii Thiosulphas.—Sodium Thiosulphate. *Synonym.*—Sodii Hyposulphis. It occurs in colourless, transparent, prismatic crystals soluble freely in water; insoluble in alcohol.

Dose—5 to 15 grs.—0·3 to 1 G. by subcutaneous, intramuscular or intravenous injection.

Action and Therapeutic Uses of Sodium Thiosulphate

It is used as a parasiticide externally. Internally, by oral as well as by injection route, it is used as an antidote to metallic poisons, pre-eminently in the treatment of exfoliative dermatitis caused by organic arsenicals. Tissue reactions, due to extravenous leakage of organic arsenicals, may be treated by infiltration of a 10 per cent. sterile solution. Intravenously it is useful even in advanced cases of pellagra.

14. **Sodii Benzoas,** see Acidum Benzoicum.

15. **Sodii Biboras,** see Acidum Boricum.

16. **Sodii Bromidum,** see Bromine.

17. **Sodii Iodidum,** see Iodine.

18. **Sodii Nitris,** see Nitrites.

19. **Sodii Salicylas,** see Acidum Salicylicum.

20. **Liquor Sodæ Chlorinatæ Chirurgicalis,** see Chlorine.

21. **Sodii Oleas,** Sapo Durus, see Olive Oil.

22. **Sapo-Animalis,** see Curd Soap. It is chiefly Sodium Stearate.

THERAPEUTIC USES OF SODIUM SALTS

The solutions of Carbonates of Sodium are used externally as sedatives in various skin diseases, in burns and scalds. The Bicarbonate of sodium is used internally as a direct and remote antacid and stomachic, in cases of gastric catarrh, dyspepsia, heart burn, etc. With or without bismuth, it is given to check vomiting. Sodium chloride in large doses is given as an emetic ; rectally in the form of an enema, it is administered for the cure of thread worms. In the form of "Normal Saline Solution," it is injected in cases of severe hæmorrhage, of loss of fluids from the body as in cholera, of toxæmia and septicæmia, of shock and of suppression of urine. The Phosphate, Sulphate and Tartrate act as hydragogue purgatives and are used in draining fluids from the body ; the phosphate in addition acts as a cholagogue. The salts of sodium are not much used in gout and rheumatism, the sodium urate that is formed being less soluble than the urate of potassium. Acid sodium phosphate increases the acidity of the urine and acts as a urinary antiseptic.

Sodium vs. Potassium Salts.—Speaking in a general way Sodium salts differ in the following respects from the corresponding Potassium salts:—(1) Sodium salts are less caustic when used externally. (2) They are less depressant to the nervous, muscular and cardiac tissues. (3) They have very little diuretic action. (4) They form less soluble salts with uric acid. (5) They are much less diffusible. (6) They do not appreciably affect metabolism owing to the entire system being saturated with them. (Whitla.)

AMMONIUM

1. Liquor Ammoniæ Fortis.—Strong solution of Ammonia containing about 30 per cent. of Ammonia. It is a colourless liquid having a pungent odour and strongly alkaline reaction. It is miscible with water in all proportions.

1. **Linimentum Camphoræ Ammoniatum.**—Compound liniment of Camphor; contains 12·5 per cent. camphor and 25 per cent. of Liquor Ammoniæ Fortis.

2. **Spiritus Ammoniæ Aromaticus,** see Ammonium Carbonate.

2. Liquor Ammoniæ Dilutus. *Synonym.*—Liquor Ammoniæ. Solution of Ammonia, a colourless liquid with a strongly alkaline reaction containing about 10 per cent. of ammonia by weight.

1. **Liquor Quininæ Ammoniata,** see Quinine.
2. **Tinctura Valerianæ Ammoniata,** see Valerian.

It is used in the preparations of Extractum Senegæ Liquidum, Infusum Senegæ Concentratum and Injectio Ferri.

ACTION OF SOLUTIONS OF AMMONIA

External.—A solution of Ammonia when rubbed in or applied to the skin, stimulates the sensory nerve-endings and produces a sensation of heat and burning. It dilates the blood vessels and causes redness of the skin and therefore acts as a **rubefacient.** Owing to the irritation of the cutaneous nerves, it causes constriction of the blood vessels of the viscera underneath and acts as a **counter-irritant.** When inhaled, the vapour of ammonia causes a pungent sensation, watery secretion from the nose and eyes and sneezing. **It acts as a powerful local and general stimulant by reflex action.**

Internal.—*Alimentary Tract.*—In the stomach, Ammonia acts like other alkalies. In small doses, it acts as a **stomachic** and a **carminative** It causes a feeling of warmth at the epigastrium and acts as a **reflex stimulant** to the heart and respiration.

Absorption and Elimination.—Ammonia vapour is rapidly absorbed through all mucous membranes and passes into the blood through them. Ammonia is readily absorbed from the stomach. It appears in the portal circulation as ammonium carbonate and is carried to the liver, where it is converted into urea and excreted as such. Ammonium salts of mineral acids, such as chloride, are excreted unchanged ; organic salts, such as citrate and acetate, are partly converted into urea, the acid radical being oxidised to carbonic acid and partly excreted unchanged.

Blood.—Since Ammonia reaches the blood as urea, it does not increase the alkalinity of the blood as other fixed alkalies.

Circulatory System.—Ammonia **reflexly stimulates the Vaso-motor centre,** and causes constriction of the blood vessels. This leads to the rise of blood pressure and in consequence the pulse becomes slow and strong for a time, but subsequently becomes fast probably by the stimulation of the acceleratory centre.

Respiratory System.—Ammonia stimulates the respiratory centre in the medulla, and increases the frequency and depth of respiration. The bronchial secretion is increased and rendered less viscid.

Nervous System.—The effects on the circulatory and respiratory systems are due to reflex stimulation of the medulla from surface irritation, for these are manifested before the drug can be absorbed. The brain and nerves are unaffected, except for the tingling produced, when strong solutions are applied locally.

Urinary System.—Ammonia and its salts are oxidised in the body and are excreted as urea, uric acid and nitric acid. The acidity of the urine is, therefore, increased. They act as **diuretics,** by their conversion into urea which causes, by salt action, increase in the secretion of urine.

3. Ammonii Bicarbonas.—It is prepared by passing carbon dioxide into the solution of Ammonia. It occurs as colourless crystals or as a crystalline powder with a slightly ammoniacal odour and a pungent taste. It volatilizes at ordinary temperature, and is soluble in 5½ parts of water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

4. Ammonii Carbonas.—Ammonium Carbonate occurs in white, hard, translucent crystalline masses, having a strong odour of ammonia and a sharp ammoniacal taste. It is a variable mixture of ammonium bicarbonate and ammonium carbonate. It contains the equivalent of not less than 30 per cent. of ammonia and is soluble in 4 parts of water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

Spiritus Ammoniæ Aromaticus. *Synonym.*—Spirit of Sal Volatile. It contains 2·5 per cent. of ammonium carbonate and 5 per cent. of liquor ammonia with aromatics.

Dose—15 to 60 ms.—1 to 4 mils.

Liquor Ammoniæ Aromaticus.—Ammon Carbonate 2·5 per cent. and 5 per cent. of strong solution of Ammonia with aromatics and water.

Dose—15 to 60 ms.—1 to 4 mils.

ACTION OF AMMONIUM CARBONATE

External.—It is rarely used externally, though it has the same actions as those of Liquor Ammonia. By inhalation it acts as a general stimulant by reflex action.

Internal.—In the stomach, it acts as an **antacid, stomachic** and **carminative.** It reflexly stimulates the heart and respiration. It is a powerful **expectorant,** increasing the bronchial secretion, stimulating the movements of respiration and aiding the expulsion of viscid mucous. In large doses (30 grs.) it is an **emetic,** acting directly on the stomach as well as reflexly.

5. Ammonium Chloridum. *Synonym.*—Sal Ammoniac. A white crystalline or granular powder having a cooling and saline taste. Soluble in 3 parts of water.

Dose—15 to 60 grs.—1 to 4 mils.

ACTION OF AMMONIUM CHLORIDE

External.—In cases of sprain, bruises and headache it is used as a soothing refrigerant in combination with alcohol and potassium nitrate.

Internal.—Ammonium Chloride resembles in its action sodium chloride. It is absorbed and diffused readily, is excreted rapidly, principally through urine and it produces the ordinary salt action, which is manifested in the irritation of the gastric mucous membrane with thirst and diuresis. It, however, causes reduction of the alkaline reserve of the blood, as it is converted by the liver into urea and hydrochloric acid. Inhalation of the vapour of Ammonium Chloride, generated in a suitable vessel by the action of hydrochloric acid on Ammonium Chloride, increases the secretion of the respiratory tract. It is supposed to increase the flow of bile and to act as a **cholagogue.** It increases the secretion of the bronchial mucous membrane and makes it less viscid so that it acts as an **expectorant.** And for neuralgia it is considered to be a specific. Ammonium Chloride differs from Ammonium Carbonate in that it has no reflex action of Ammonia.

6. Liquor Ammonii Acetatis Fortis.—Strong solution of Ammonium Acetate. A thin syrupy liquid with an odour of ammonia and of acetic acid. It consists of 33 per cent. of

Ammonium Carbonate and 45 per cent. of Glacial Acetic Acid. It should be kept in a bottle of lead-free glass.

Dose—5 to 60 ms.—0·3 to 0·4 G.

7. Liquor Ammonii Acetatis Dilutus.—Dilute solution of Ammonium Acetate. *Synonyms.*—Liquor Ammonium Acetatis, Minderer's Spirit. It is a colourless liquid with a mild saline and acidulous taste. It contains 7·2 per cent. of Ammonium Acetate. It is a 12·5 per cent. solution of strong solution of Ammonium Acetate in distilled water.

Dose—¼ to 1 fl. oz.—8 to 30 mils.

ACTION OF AMMONIUM ACETATE

This salt acts as a mild **diaphoretic** and **diuretic.** The diaphoretic action is due to its effect on the sweat centres, and the diuretic action is due to the stimulation of the kidney cells by the urea into which it is oxidised in the body.

THERAPEUTIC USES OF AMMONIA AND ITS SALTS

Ammonia is a good counter-irritant and forms part of stimulating liniments. It is applied to the sting of insects and the bites of poisonous snakes. Vapour of ammonia is inhaled as a diffusable stimulant to rouse patients from fainting, shock, syncope and narcotic poisoning. Ammonium chloride is used as an ingredient of evaporating lotions. It is employed in bronchitis in conjunction with other expectorants, when the sputum is scanty and tenacious. It is recommended in catarrhal jaundice, cirrhosis of the liver, and nervous headache. Ammonium carbonate and spirit ammoniæ aromaticus are used as diffusible stimulants, antacids and gastric and intestinal carminatives. Ammonium carbonate is also used as an emetic and respiratory stimulant. **Liq. Ammonium Acetate is used in fever and in kidney diseases.**

GROUP II

METALS OF THE ALKALINE EARTHS AND THEIR ALLIES

Calcium, Magnesium, Barium

CALCIUM

Calcium is a normal constituent of tissues of both plants and animals. It is indispensable to life. The functional activity of nerve and muscle cells depends on its presence and is markedly influenced by any deficiency or excess. Most of the calcium salts which are used medicinally depend for their action on the anion.

1. Creta. *Synonym.*—Creta Præparata. Prepared chalk, a native form of calcium carbonate, freed from its impurities by elutriation. It occurs in dull white friable masses or in powder, insoluble in water.

Dose—15 to 60 grs.—1 to 4 G.

1. **Hydrargyrum cum Creta,** see Mercury.
2. **Pulvis Cretæ Aromaticus.**—Contains chalk, sugar and carminatives.

   Dose—10 to 60 grs.—1 to 4 G.
3. **Pulvis Cretæ Aromaticus cum opio,** see Opium.

2. Calcii Carbonas.—Calcium Carbonate. *Synonym.*—Calcii Carbonas Præcipitatus; Precipitated Chalk. A white powder insoluble in water.

Dose—15 to 60 grs.—1 to 4 G.

It is contained in Trochiscus Bismuthi Compositus.

3. Calcii Hydroxidum.—Calcium Hydroxide. *Synonym.*—Calcii Hydras, Slaked Lime. A white strongly alkaline powder soluble in 900 parts of water; more soluble in solutions of glycerine and sugars.

Incompatibles.—Acids, Metallic salts and Antimony Tartrate.

Dose—5 to 15 grs.—0·3 to 1 G.

Liquor Calcii Hydroxidi. *Synonym.*—Liquor Calcis, Lime water. A saturated solution of Calcium Hydrate containing not less than 0·15 per cent. of slaked lime.

Dose—1 to 4 fl. oz.—30 to 120 mils.

4. Calcii Chloridum.—Calcium Chloride. It occurs in white porous masses or in granules, with a disagreeably saline bitter taste, very deliquescent and readily soluble in water.

Dose—10 to 30 grs.—0·6 to 2 G. by mouth.
½ to 1½ grs.—0·3 to 0·1 G. by intramuscular injection.
5 to 15 grs.—0·3 to 1 G. by intravenous injection.

5. Calcii Chloridum Hydratum.—Hydrated Calcium Chloride. It occurs in colourless, odourless, acicular crystals. Very deliquescent ; with a slightly bitter taste. Soluble 4 in 1 part of water and 1 in 1 of alcohol 90 per cent. It contains 98 to 102 per cent. of hydrated Calcium Chloride.

Dose—1 to 3 grs.—0·06 to 0·2 G. by intramuscular injection.
10 to 30 grs.—0·6 to 2 G. by intravenous injection.

6. Calcii Gluconas.—Calcium Gluconate. A white crystalline or granular powder, soluble in 1 in 30 water, 1 in 5 of boiling water. Insoluble in dehydrated alcohol, in ether, and in chloroform. It contains 8·9 per cent. of calcium.

Dose—30 to 60 grs.—2 to 4 G.

Injectio Calcii Gluconatis.—It contains in 300 minims about 30 grains of Calcium Gluconate.

Dose—150 to 300 ms.—10 to 20 mils.

7. Calcii Lactas.—Calcium Lactate, a white powder almost tasteless, soluble in 18 parts of water.

Dose—15 to 60 grs.—1 to 4 G.

8. Calcii Phosphas.—Calcium Phosphate. *Synonym.*—Phosphate of lime. A white, amorphous powder insoluble in water. It is odourless and almost tasteless.

Dose—10 to 30 grs.—0·6 to 2 G.

9. Calx Chlorinata, see Chlorine.

ACTIONS OF CALCIUM SALTS

External.—Calcium in the form of prepared chalk or lime water, is used as a mild **astringent** and an **antacid.** These preparations help to dry up moist surfaces. Calcium oxide or lime is used as a **caustic** but unlike that of caustic alkalies, the action is superficial, as it forms insoluble compounds with the acids and fats of the tissues.

Internal.—*Alimentary Tract.*—The insoluble calcium ions in the mouth, stomach and intestines act as **antacid** and **astringent.** They act by neutralizing the free acids, by forming chloride or lactate, and an insoluble coating of precipitated proteins on the mucous membrane ; and by diminishing the permeability of the mucous membrane. As a result of this triple action, calcium ions act as **gastric sedatives** and **intestinal astringents.**

Absorption and Elimination.—Calcium salts, both soluble and insoluble, are absorbed with difficulty ; but their absorption is favoured by intestinal acidity, as shown by the administration of dilute acid and by the addition of lactose to the food, probably because of the formation of lactic acid in the intestines. With the unsaturated fatty acids in the intestines it forms soluble soap, which is taken up by the intestinal epithelium, and its absorption from the bowel is facilitated by the fat soluble vitamin D. The absorbed portion circulates in the blood partly as diffusible salts, and chiefly in combination with proteins. It is slowly excreted from it in part in urine, but in a larger amount, through the large intestine as calcium phosphate and carbonate to produce its astringent action. The elimination of calcium is hastened by the administration of magnesium.

Tissues.—The soluble calcium salts have an important function in the body. They are a normal constituent of all the tissues especially the bones. They enter the circulation in minute quantities, and if the tissues are deficient in calcium, it is utilized by them or otherwise excreted. The effects of soluble calcium salts are more marked when given intravenously than by mouth. They have a great affinity with all the muscles of the body; and they increase the contractile power of voluntary muscles in response to stimuli. They raise the tonus of the involuntary muscles and thus increase the force of the cardiac muscle, slow down its rhythm, contract the arterioles and raise the blood pressure. The deficiency of calcium increases the excitability of the voluntary muscles and renders the bones soft and spongy. This leads to rickets in children and osteomalacia in adults.

Blood.—Soluble calcium salts, the chloride and the lactate, act as **hæmostatic.** They play an important part in the coagulation of the blood by increasing its calcium contents. Their absence or deficiency in the blood, prevents the activation of the ferment necessary for the clotting of blood. They prevent diapedisis of the leucocytes and check inflammatory exudation. They have, therefore, been used successfully in urticaria and other skin diseases.

Urinary System.—Whether the calcium salts have any action on the kidneys is doubtful. But as the administration of certain spring waters containing calcium carbonate and sulphate increases the quantity of urine the **diuretic action** may be essentially due to the water drunk or to the depletion of alkali reserve of the plasma by the absorption of chloride ion. If their administration is continued long, they render the urine alkaline, and may prove helpful in uric acid gravel to dissolve the calculi. They have been credited with the power of reducing glycosuria and cyclic albuminuria; when albumen, however, is due to nephritis, the drug is of no service.

THERAPEUTIC USES OF CALCIUM SALTS

Prepared chalk and lime water are very largely used as antacid and astringent to check vomiting and diarrhœa especially in children. Lime water is added to the milk of hand-fed children to prevent its lumpy clotting which will remain undigested and form a source of irritation to the mucous membrane. Calcium Phosphate is used as a promoter of nutrition and cell growth in children who have overgrown their strength. It is also used in cases of delayed union of fracture. Women suffering from anæmia and exhaustion, brought on by frequent childbearing or prolonged suckling, are greatly benefited by its use. Calcium chloride and lactate are used as hæmostatics in cases of internal hæmorrhage. They are also used as cardiac tonics in cases of pneumonia. They are said to be useful in serum sickness, urticaria and other skin diseases. Liniment calcis forms a soothing application to burns and acute inflammations of the skin.

BARIUM

Barii Sulphus.—Barium Sulphate. A heavy white amorphous powder without odour or taste. It is insoluble in water.

ACTION AND THERAPEUTIC USES

Barium salts are seldom given internally for any therapeutic effect. Barium sulphate has official recognition on account of its being largely employed to render meals opaque in X-ray examination of the intestinal movements. Precaution must, however, be taken not to use barium sulphide in the place of sulphate, the former being extremely poisonous; and is used diluted with starch, only as a depilatory.

MAGNESIUM

1. **Magnesii Sulphus.**—Magnesium sulphate. *Synonym.*—Epsom Salts. Small prismatic crystals having a cooling saline bitter taste. Very soluble in water. It resembles zinc sulphate which has a metallic taste.

Incompatibles.—Alkaline carbonates, Lime water. Lead acetate and silver nitrate.

Dose—30 to 240 grs.—2 to 16 G.

1. Mistura Magnesii Hydroxidi. *Synonym.*—Cream of Magnesia. It contains 4·8 per cent. of magnesium sulphate; 5·3 per cent. of light magnesium oxide and 1·5 per cent. of sodium hydroxide in distilled water.

Dose—60 to 240 ms.—4 to 16 mils.

2. Mistura Sennæ Composita.—Contains magnesium sulphate (see Senna).

2. Magnesii Carbonas Ponderosus.—Heavy Magnesium Carbonate; a white heavy powder of slightly earthy taste. Practically insoluble in water.

Dose—10 to 60 grs.—0·6 to 4 G.

It is contained in Trochiscus Bismuthi Compositus and Pulvis Rhei Compositus.

Liquor Magnesii Bicarbonatis. *Synonym.*—Fluid Magnesia. A clear effervescing fluid containing 2 per cent. of Magnesium Carbonate.

Dose—1 to 2 fl. oz.—30 to 60 mils.

3. Magnesii Carbonas Levis.—Light Magnesium Carbonate, occurs in very light powder or friable masses. Insoluble in water.

Dose—10 to 60 grs.—0·6 to 4 G.

It is contained in Pulvis Rhei Compositus.

4. Magnesii Oxidum Ponderosum.—Heavy Magnesium Oxide. *Synonyms.*—Magnesia Ponderosa, Heavy Magnesia. It is a heavy white powder insoluble in water.

Dose—10 to 60 grs.—0·6 to 4 G.

5. Magnesii Oxidum Leve.—Light Magnesium Oxide. *Synonyms.*—Magnesia Levis, Light Magnesia. It is a light bulky white powder almost insoluble in water.

Dose—10 to 60 grs.—0·6 to 4 G.

6. Magnesii Trisilicas.—Magnesium Trisilicate, a white powder, slightly hygroscopic; insoluble in water.

Dose—5 to 30 grs.—0·3 to 2 G.

ACTION OF MAGNESIUM SALTS

External.—A strong solution of Magnesium Sulphate is used as **local anodyne** and **anæsthetic** in acute inflammatory conditions.

Internal.—*Alimentary Tract.*—Alkaline salts of Magnesium, the oxides and the carbonates, neutralize the acidity of the stomach and act as **Antacids.** Magnesium trisilicate 60 grs. doses is an excellent antacid. It neutralizes by the formation of the chloride and partly by absorption of free hydrochloric acid. The **carbonates** yield carbonic acid and act as **sedative** to the gastric mucous membrane, a quality not possessed by the oxides. Owing to slow absorption of magnesium on, they reach the intestines, where they are converted into salts of magnesium which have a **purgative** effect. In the intestine, magnesium sulphate acts as a typical saline purgative. Cation and anion of magnesium sulphate are both slowly absorbed from the intestine and by salt action they act as a hydragogue purgative.

Absorption and Elimination.—The soluble salts of magnesium are slowly absorbed but are quickly excreted in the urine, preventing their accumulation in the system. A small quantity of the insoluble salts is converted into chloride, carbonate and lactate and the remaining portion passes out with the fæces.

Urinary System.—When magnesium salts do not purge, they are excreted by the kidneys and act as diuretics by salt action, but they do not alkalize the urine.

Nervous System.—Taken by mouth, owing to their slow absorption, and quick excretion, they do not reach that concentration necessary to affect the central nervous system ; but when injected hypodermically or intravenously, they act as narcotics by central action and depress the heart, muscles and the central nervous system, death taking place by paralysis of the respiratory centre. Injection of the solution of magnesium sulphate into the spine induces anæsthesia closely resembling cocaine but more lasting. Spinal injections are used to alleviate the pain and spasm of tetanus. A complete recovery from the poisonous effects produced by such administration is brought about by the injection of calcium in the vein. It combines with magnesium to form inert triple phosphate which is rapidly excreted.

THERAPEUTIC USES

Magnesia and the carbonates are largely used as antacids in acid dyspepsia, heart burn and vomiting, either alone or in combination with bismuth carbonate or bicarbonate of soda. They are used as laxatives in constipation of children. They form innocuous compounds with mineral acids, oxalic acid, alkaloids, salts of mercury, copper and arsenic and are used as antidotes in cases of poisoning by these substances.

The Sulphate of Magnesium is used as a hydragogue purgative for drawing a large quantity of fluid from the body and is used in anasarca and ascites. Like all saline purgatives, it is best administered in the morning, well diluted and on an empty stomach. A saturated solution in teaspoonful doses every hour, is used in cases of bacillary dysentery. Recently, it has been found useful in relieving the spasms of tetanus; for this purpose, it is administered intraspinally, the dose being 1 c.c. of 25 per cent. solution to each 22 pounds of body weight.

GROUP III

HEAVY METALS

Plumbum, Zincum, Argentum, Cuprum, Aluminium, Ferrum, Manganesium, Chromium, Hydrargyrum.

General Characteristics.—Heavy metals such as lead, silver, zinc, copper, bismuth and aluminium have no action on the system, but their different salts have many features in common. Locally, the soluble salts of these metals precipitate proteins, form albuminates of variable composition and contract the blood vessels by their direct action upon their walls, and thus they act as **astringents.** In concentrated solutions, they irritate and even destroy the tissues and act as **caustics.** These local actions depend upon the interaction between the metallic ions and proteins ; the intensity of this action varying with the degree of ionization and the solubility of the salt employed. The anions, therefore, are most important for their local action. Anions of chlorides and nitrates which are dissociated most rapidly from the salts, have a powerful caustic action. Anions of sulphates are dissociated less rapidly and act as irritants, while organic anions are the least corrosive. These metals are slowly absorbed, except mercury ; and their excretion is even slower than their absorption. They accumulate in the internal organs of the body such as liver, spleen, kidneys, bone marrow, etc., and produce symptoms of chronic poisoning. They have, therefore, a **cumulative action,** which is markedly seen in the case of lead, mercury and arsenic, if their administration is continued long. The symptoms of poisoning produced are mainly referable to (*a*) the nervous system, when they are manifested as delusions, delirium, stupor, tremors, spasms or convulsions with peripheral neuritis and paralysis ; and (*b*) the gastro-intestinal tract, when they are manifested as pain, nausea, vomiting and diarrhœa. The unstripped muscular fibres of the intestines and uterus are thrown into tonic contraction by their direct action on them and produce colicky pains which are accompanied by constipation in the case of intestine and abortion in the case of uterus. They are all excreted by the large intestine, as well as by the kidneys, which are very often inflamed by large doses.

These metals, according to their prominent action and uses, are classified into the following groups :—

Class I.—Astringents.—Lead, Zinc, Silver, Copper and Aluminium.

Class II.—Hæmatinics.—Iron and Manganese.

Class III.—Antiseptics.—Chromium.

Class IV.—Antisyphilitic.—Mercury.

Class I

PLUMBUM

(Lead)

1. Plumbi Monoxidum.—Lead Monoxide. *Synonyms.*—Plumbi Oxidum, Litharge—a heavy orange red powder or scales insoluble in water, but soluble in nitric and acetic acids.

Emplastrum Plumbi. *Synonym.*—Diachylon Plaster. Olive oil in its composition combines with lead to form lead oleate and is sometimes called lead soap.

It is contained in Emplastrum Colophoni.

2. Plumbi Acetas.—Lead Acetate. *Synonym.*—Sugar of lead. It occurs in colourless crystals of sweet astringent taste with faintly acetous odour. They are efflorescent and readily soluble in water.

Dose—½ to 2 grs.—0·03 to 0·02 G.

Suppositoria Plumbi cum Opio.—Contains about 3 grs. of lead acetate and about 1 gr. of opium.

Plumbi Subacetatis—is official only in the form of liquors and is a mixture of lead oxide and acetate in water. The solution of subacetate, thus formed, is distinguished from that of acetate by its alkaline reaction.

1. **Liquor Plumbi Subacetatis Fortis.**—Strong solution lead subacetate. *Synonym.*—Goulard's extract. Contains about 20 per cent. of the subacetate. It is generally used in the official dilution mentioned below.
2. **Liquor Plumbi Subacetatis Dilutus.** *Synonym.*—Goulard's water or lotion, prepared by diluting the strong solution in 80 parts of water.

ACTION OF LEAD SALTS

External.—Applied to raw surfaces, lead salts, by combining with the albumen of the discharge, form an insoluble dense deposit which covers and protects the part. They coagulate the albumen in the tissues and directly constrict the small blood vessels. They thus act as powerful **astringents** and **hæmostatics.** They also depress the nerve endings and act as local **sedatives.**

Internal.—*Alimentary Tract.*—Lead salts act on the mucous membrane of the mouth, throat, stomach and intestines as on the broken skin. In the stomach they diminish the secretion and vascularity of the mucous membrane, coagulate the albumen of the food and may cause indigestion. In the intestines, they inhibit or destroy the secretion of the succus entericus, retard the peristaltic movement by the formation of a protective layer of the coagulated albumen, and cause constriction of the capillaries of the mucous membrane. They, by this combined action, act as powerful intestinal **astringents** and **hæmostatics.**

Absorption and Elimination.—Lead salts are absorbed into the blood from raw surfaces, through the lungs when inhaled in the form of fine dust, and from the gastro-intestinal tract as chloride and albuminate of lead. After absorption, they remain for a long time in the body. The unabsorbed portion is eliminated as sulphide, with the fæces. It is slowly excreted through the kidneys, intestinal epithelium, saliva, bile and milk.

Blood.—During their sojourn in the blood, they disintegrate the red blood corpuscles, diminish the amount of hæmoglobin and cause **anæmia** to supervene. They check the separation of urates from the blood and their excretion from the kidneys. From the blood lead is carried to the tissues and is principally deposited in the central nervous system, liver, kidneys and bones.

Tissues.—Lead has a special affinity for unstripped muscles, excites tonic contraction in them, and induces colic and abortion.

Plumbism.—Very slow excretion of lead salts causes cumulation and produces symptoms of plumbism or chronic lead poisoning. It is to be generally found in persons working in lead. The earliest symptoms manifested are a metallic taste in the mouth, nausea, vomiting, loss of appetite and constipation. Along with these symptoms, there is the formation of a blue line, at the base of the gums, due to the formation of lead sulphide—sulphur being provided by the food and the tartar of the teeth. Sallow appearance, anæmia and severe attacks of intestinal colic supervene. Later on, there occurs a curious form of paralysis, known as "wrist drop." This is due to the inflammatory changes in the nerves supplying the extensor muscles of the fingers and the wrist. Other peripheral nerves are also affected. Sensory nerves are not often affected. The pain round the joints of persons with gouty diathesis is aggravated. In exceptional cases there is blindness caused by inflammation of the optic nerve or optic neuritis, or it may lead on to lunacy and convulsions. Finally inflammation of the kidneys and general arteriosclerosis ensue and prove fatal. In women, chronic lead poisoning causes abortion.

THERAPEUTIC USES

Lead salts, in diluted solutions, are used as lotions in acute inflammation of the skin. They are also used as injections for discharging mucous surfaces and are used with benefit in vulvitis, leucorrhœa, gleet, etc. Lead and opium lotion is a good antiphlogistic and sedative application, in cases of sprain and bruises. As an astringent eyewash, lead lotion should be used with caution particularly in ulcerated cornea, as a deposit of lead may form causing permanent opacity. The ointments of lead act as astringent and sedative applications to ulcers and chronic affections of the skin. Internally, lead acetate is used as an astringent in diarrhœa, especially that of typhoid fever and phthisis. It is also used as a hæmostatic in gastric ulcer and in hæmorrhages from the intestines. For this purpose, it is generally given in the form of lead and opium pill. Suppository may be used in cases of bleeding from the rectum. The solution of the lead acetate is also used as a gargle in tonsillitis.

ZINCUM

(Zinc)

1. **Zinci Chloridum.**—Zinc chloride occurs as opaque white rods or granular powder, very deliquescent and caustic. It is freely soluble in water and alcohol.

2. **Zinci Sulphas.**—Zinc sulphate. Colourless crystals which effloresce in dry air; readily soluble in water. They resemble the crystals of magnesium sulphate, but have a metallic taste.

Incompatibles.—Alkalies, Carbonates, Tannins, Lead salts, Sodium Borate, and Milk.

Dose—1 to 3 grs.—0·06 to 0·9 G. as tonic.
10 to 30 grs.—0·6 to 2 G. as an emetic.

Unguentum Zinci Oleatis.—A zincsoap containing zinc sulphate and hard soap incorporated with white soft paraffin.

3. **Zinci Oxidum.**—Zinc oxide, a light white powder free from grittiness, insoluble in water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

1. **Unguentum Zinci Oxid.**—Contains 15 per cent. of zinc oxide.
2. **Gelatinum Zinci,** see Gelatin.
3. **Pasta Zinci Oxidi Composita.**—Zinc paste. It is made with zinc oxide 25 per cent. with starch and soft whit paraffin.

4. **Zinci Stearas.**—Zinc Stearate. A compound of zinc with fatty acids, principally stearic acid. A white amorphous powder, insoluble in water.

ACTION OF ZINC SALTS

External.—Locally, zinc salts have an **astringent** or **corrosive** action, according to the acid with which the metal is combined. Zinc chloride, being a highly deliquescent salt, **spreads over moist surfaces and penetrates deeply to act as a**

powerful caustic, causing great pain. In the form of liquor, it is used as a disinfectant and deodorizer for sanitary purposes. Zinc sulphate acts as an astringent. Zinc salts precipitate the albumen in the discharge and plasma and directly constrict the capillaries to act as **hæmostatics.** The insoluble salts of zinc, the oxide and stearate combine slowly with the proteins and exert less energetic, but more prolonged action, than the soluble salts. They act as mild astringent and **antiseptics** in skin diseases.

Internal.—Zinc salts have an **astringent** effect on gastric and intestinal mucous membranes. In large doses, they act as gastro-intestinal irritants producing vomiting, purgation and symptoms of collapse. Zinc sulphate in large doses acts directly on the stomach to produce a prompt **emetic** action with very little depression. Carbonate and oxide of zinc are converted in the stomach to chlorides and may induce vomiting. Nothing definite is known about the action of zinc salts on the blood. They are supposed to have a depressant action on the central nervous system. They have no remote astringent effect and their action in checking the night sweats of phthisis is so far unexplained. Prolonged administration of zinc salts produces symptoms like those of chronic lead poisoning.

THERAPEUTIC USES

The chloride of zinc is used as a caustic to destroy malignant growths, poisoned wounds and warts. In solution it is used as a sanitary disinfectant. In the form of Lotio Rubra, it is applied as a stimulating astringent to all sorts of raw surfaces and ulcers. Zinc sulphate in large doses is used as an emetic in case of poisoning. In tonic doses, it is used as a nervous depressant in diseases like epilepsy and hysteria. Zinc oxide is used as a protective and mild astringent in various skin diseases. Internally, it is given in epilepsy and to check night sweats of phthisis. It is sometimes given to check diarrhœa.

ARGENTUM

(Silver)

1. Argenti Nitras.—Silver Nitrate. *Synonym.*—Lunar caustic. Colourless tabular crystals; very soluble in water. It must be kept in the dark as it blackens on exposure to light.

Incompatibles.—Alkalies and their Carbonates. Chlorides, Iodides, Tannins, solutions of Arsenic and Acids (except nitric and acetic).

Dose—⅛ to ¼ gr.—0·008 to 0·016 G. It is administered in a pill with Kaolin.

2. Argenti Nitras Induratus. *Synonym.*—Toughened Caustic. It is the nitrate fused with a small quantity of potassium nitrate and poured into proper moulds. It occurs in greyish white cylindrical rods or cones and is freely soluble in water.

3. Argentoproteinum.—Silver Protein. *Synonyms.*—Argentum-Proteinium Forte, Silver Proteinate, Argein, Protorgol. It is a brownish yellow powder, somewhat hygroscopic. It contains 7·5 to 8·5 per cent. of silver. Soluble in 2 parts of water; insoluble in alcohol, in chloroform and in ether. It is a compound of silver and protein, which may be prepared by the action of silver compound on gelatin in the presence of alkali. Powder should be kept in a well-closed container, protected from light. Solutions should be freshly prepared and dispensed in amber-coloured bottles.

ACTION OF SILVER NITRATE

External.—Silver nitrate in solid form when applied to the tissues acts as a **caustic** with a limited action, for unlike caustic potash or zinc chloride, it cannot penetrate into the deeper tissues owing to the presence of sodium chloride which converts it into insoluble silver chloride. In diluted solution, it coagulates the protein of the discharge, and albumen in the tissues and also by direct action it constricts the blood vessels. Silver nitrate also precipitates the protein of bacteria and possesses specific and toxic powers towards them. It, therefore, acts as an **astringent, hæmostatic** and **antiseptic.**

Internal.—Locally in the mouth, it produces its **astringent** action which is rapidly annulled by the formation of insoluble silver albuminate and chloride. In the stomach, it has a slight astringent action, but it has no astringent action in the intestine, as it is precipitated in the stomach as silver chloride which in the intestine is reduced to metallic silver. In spite of the precipitation of silver nitrate in the stomach, minute quantities of silver are absorbed as an albuminate or in some soluble form. Its continuous administration, therefore, produces duskiness of the skin of the exposed parts, which gradually deepens into a brownish green colour, due to the storage of an organic compound chiefly in the connective tissue. This is known as **argyrism** or **argyria,** the chronic poisoning by silver. The colour is due to the deposit of minute quantities of metallic silver. Silver is excreted with the fæces as sulphide. Some of the silver is also deposited in the internal organs, especially the liver, kidneys and the nervous system.

THERAPEUTIC USES

Solid silver nitrate owing to its limited action, is a useful caustic, and is used to destroy warts, small growths and exuberant granulations. It is also used as an application for simple venereal sores, and ulcerated and poisoned wounds. It is used as a hæmostatic in bleeding from leech bite. In solutions of different strengths, it is used in conjunctivitis, ophthalmia neonatorum and as injections in gonorrhœa and leucorrhœa. The solution of silver nitrate is used as a paint to sore throat and in tonsillitis. As an enema (10 grs. to a pint), it is used in severe diarrhœa, dysentery and ulceration of the bowels. Internally, it is rarely used, though it is helpful in gastric ulcer and in chronic diseases of the stomach. Certain nervous affections are said to be benefited by its use. To obviate the irritant action of its acid radical, the protein compounds of silver, such as **protargol, argyrol** and others, are nowadays largely used. They are less irritating than silver nitrate, as there is very little silver in ionizable form to unite with the proteins of the tissues. Their antiseptic value, which depends on ionizable silver, is, therefore, also less.

CUPRUM

(Copper)

Cupri Sulphas.—Copper Sulphate. *Synonyms.*—Blue Vitriol, Blue Stone. Deep blue crystals readily soluble in water. Solution is strongly acid.

Dose—¼ to 2 grs.—0·06 to 0·12 G. (astringent).
5 to 10 grs.—0·3 to 0·6 G. (emetic).

Action of Copper Sulphate

External.—Copper sulphate in the solid form or in very concentrated solution is a **caustic.** In weaker solution, it is **antiseptic** and **astringent.**

Internal.—In small doses, copper sulphate acts as an **astringent** in the stomach, but in large doses, it is chiefly used as an **emetic** producing vomiting in about 10 to 20 minutes without any unpleasant preliminary nausea, and increased secretion from various glands. In prescribing it as an emetic, the following precautions should be taken :—

(1) It should not be given in the form of powder or crystals, as it is likely to corrode the mucous membrane of the mouth and the œsophagus owing to its caustic action. (2) It should not be given in too strong a solution, for it will cause an undue amount of irritation. (3) Nor should it be given in too weak a solution, as it will not cause sufficient irritation to produce vomiting; and if it fails to induce

vomiting symptoms of gastroenteritis supervene and may cause abdominal pain, tenesmus and violent diarrhœa. The usual strength of the copper sulphate to induce vomiting is about 1 per cent., and if this fails to induce vomiting within about 10 to 15 minutes, the stomach must be emptied to prevent inflammation of the stomach and intestine. Copper sulphate is largely used in cases of Phosphorus poisoning. The phosphorus is oxidised to phosphate by copper sulphate, and any unchanged phosphorus combines with the reduced copper to form an insoluble and inert phosphide. Minute doses of copper given in the form of sulphate are supposed to promote the assimilation of iron salts in anæmias.

THERAPEUTIC USES

Externally, copper sulphate is used as an astringent and caustic application to chronic ulcers, granular eyelids and exuberant granulations on raw surfaces. Internally, it is given as an emetic and is employed in laryngitis and bronchitis in children, and in cases of narcotic poisoning. It is particularly serviceable in phosphorus poisoning.

ALUMINIUM

Alumen.—Alum. *Synonym.*—Alumen Purificatum. It is a sulphate of Aluminium and Potassium (potassium alum) or sulphate of Aluminium and Ammonium (Ammonium alum). It occurs in colourless, crystalline masses with a sweetish, astringent taste ; very soluble in water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

Glycerinum Aluminis.—Contains 13 per cent. of alum.

Dose—30 to 60 ms.—2 to 4 mils.

ACTION OF ALUM

External.—Salts of aluminium have actions similar to those of copper and zinc. Alum has no action on the unbroken skin but on raw surfaces it acts as an **astringent**

and **styptic** by coagulating the albumen of the discharge and by constricting the blood vessels.

Internal.—Alum acts as an **astringent** over the whole of the alimentary tract and induces constipation. In large doses, it acts as an **emetic** acting directly on the stomach, and in still larger doses, it acts as an irritant to the intestinal tract and causes diarrhœa. Most of the alum is excreted with the fæces.

THERAPEUTIC USES

Alum is used as an astringent-wash in conjunctivitis, leucorrhœa, gonorrhœa, etc. Powdered alum is applied locally to stop bleeding in epistaxis, wounds, ulcers, piles, leech bite, gums, etc. Alum gargles are used in spongy gums, tonsillitis, sore throat and ulcerative stomatitis. Glycerine of alum as a paint is also excellent for these conditions. It is an excellent emetic for children to excite vomiting in croup and bronchitis, as it is non-depressant. It is useful in lead poisoning, as it acts by precipitating lead salts as insoluble sulphates.

Kaolinum.—Kaolin. It is a native aluminium silicate, powdered and freed from gritty particles by elutriation. It occurs as a soft white powder insoluble in water and dilute acids. It is a bland non-oxidisable substance.

Dose—½ to 2 ozs.—15 to 60 G.

Cataplasma Kaolini.—Poultice of Kaolin. It contains boric acid, methyl-salicylate, oil of peppermint, thymol, in a base of Kaolin and Glycerine.

ACTION AND THERAPEUTIC USES

Kaolin has two important actions: adsorption and mechanical. It adsorbs to itself ferments, certain toxins and alkaloidal poisons. It has, therefore, been given internally in poisoning by various alkaloids, in food poisoning and in intestinal auto-intoxication. By forming an adherent coating over the bowel wall it soothes and protects the excoriated or inflamed mucous membrane against an irritation from the bowel contents or digestive secretions; it has been employed with benefit in diarrhœa, dysentery and cholera. Externally on the skin, it takes up the sebaceous secretion and acts as a protective for wounds, ulcers and moist eczema. Poultice of Kaolin is largely used to supply moisture and warmth in inflammatory conditions, superficial or deep, as it retains the heat for a long time.

Class II

FERRUM

(Iron)

General Remarks.—Iron in its metallic form is official. It oxidises in moisture and forms two kinds of salts—Ferrous and Ferric. Ferrous or Protosalts, contain lower oxide of iron, FeO. and have a greenish colour. They give a white precipitate with potassium ferrocyanide, turning blue on exposure to air. Ferric or Sesqui-salts contain higher oxide of iron Fe_2O_3 and have a reddish colour. They give at once a deep blue colour with potassium ferrocyanide. Ferrous salts, however, soon become ferric, by absorbing oxygen from the air, or in the presence of oxidising agents as chlorine, nitric acid, etc. In ferrous and ferric salts, iron is in ionic form, *i.e.*, it can be separated from them by electrolysis. There is a third group of iron salts, known as double salts of iron, containing citric and tartaric acid, where the iron is in the non-ionizing form. These salts are in the form of scales and have for their basis ferric hydrate. Though all iron preparations act as **hæmatinics** yet there are slight differences of action. Ferrous salts and scaly preparations of iron are non-astringents, and non-constipating. They do not form inky preparations with tannin, and they do not upset digestion; but, as hæmatinics, they are inferior to ferric salts.

1. Ferrum.—Iron, in the form of fine, bright, and non-elastic wire, or wrought iron nails, free from oxide.

Syrupus Ferri Iodidi.—A pale green liquid with a strong iron taste; contains about 5 per cent. of ferrous iodide, formed by the interaction of iron and iodine in dilute hypophosphorus acid. It is liable to change its colour to yellow, due to the formation of oxy-iodide of iron and free iodine, but it may be retarded by the addition of some more glucose.

Dose—30 to 120 ms.—2 to 8 mils.

Syrupus Ferri Phosphatis Compositus. *Synonyms.*—Parrish's food; Chemical food. It contains 1⅛ grain of anhydrous ferrous phosphate or about ½ grain of iron and 1¾ grains of tricalcium phosphate in 120 minims.

Dose—30 to 120 ms.—2 to 8 mils.

Syrupus Ferri Phosphatis cum Quinina et Strychnina· *Synonym.*—Easton's Syrup. It contains 1 grain of anhydrous ferrous phosphate or about ⅓ grain of iron, about ⅘ grain of quinine sulphate and about $\frac{1}{60}$ grain of strychnine hydrochloride in 60 minims.

Dose—30 to 60 ms.—2 to 4 mils.

2. Ferrum Reductum.—Reduced iron, a fine greyish black powder, obtained by the action of hydrogen upon ferric hydroxide. It contains not less than 80 per cent. of metallic iron.

Dose—1 to 10 grs.—0·06 to 0·6 G.

FERROUS SALTS

3. Ferri Sulphas.—Ferrous Sulphate; large, pale-green crystals; odourless, with a saline styptic taste; efflorescent in dry air. Freely soluble in water. Contains in 5 grains about 1 grain of iron.

Dose—1 to 5 grs.—0·06 to 0·3 G.

1. Ferri Sulphas Exsiccatus.—Exsiccated Ferrous Sulphate, a greyish white powder, obtained by depriving ferrous sulphate of its water of crystallization. Contains in 3 grains about 1 grain of iron.

Dose—½ to 3 grs.—0·03 to 0·2 G.

2. Pilula Ferri Carbonatis. *Synonyms.*—Pilula Ferri; Blaud's Pill. Contains 20 per cent. of ferrous carbonate or 10 per cent. of iron; obtained by interaction of exsiccated ferrous sulphate and exsiccated sodium carbonate in the pill mass.

Dose—5 to 30 grs.—⅓ to 2 G.

3. Pilula Aloes et Ferri, see Aloes.

4. Ferri Carbonas Saccharatus.—A greenish brown powder of a sweetish taste, gradually becoming oxidised by contact with air. Contains not less than 50 per cent. of ferrous carbonate. The addition of sugar is for the purpose of preventing ferrous carbonate from giving off carbonic acid and absorbing oxygen; otherwise the salt will be converted into basic carbonate and finally into ferric hydroxide. It should always be prepared as fresh as possible.

Dose—10 to 30 grs.—0·6 to 2 G. It is given in a cachet or as a lozenge.

5. Ferri Subchloridum Citratum.—Citrated Ferrous Chloride. It is a preparation of ferrous chloride and citric acid. A buff-coloured powder with a metallic and an astringent taste. Completely soluble in 1 part of water and in dilute mineral acids. It contains in 5 grs. about 1½ grs. of iron.

Dose—3 to 5 grs.—0·2 to 0·3 G.

FERRIC PREPARATIONS

6. Liquor Ferri Perchloridi.—Solution of ferric chloride obtained by the interaction of diluted hydrochloric acid and iron. Contains 15 per cent. of ferric chloride.

Dose—5 to 15 ms.—0·3 to 1 mil.

7. Ferri et Ammonii Citras.—Iron and Ammonium Citrate. It occurs in dark red shining scales. It is deliquescent in moist air and is readily soluble in water. It contains about 22 per cent. of iron or 15 grains contains 3 grains of iron.

Dose—5 to 15 grs.—0·3 to 1 G.

Injectio Ferri.—Injection of iron. It contains in 30 minims the equivalent of about $\frac{1}{10}$ gr. of Iron or of about ½ gr. of Iron and Ammonium Citrate.

8. Ferri et Quininæ Citras.—Iron and Quinine Citrate. Greenish yellow scales of a bitter taste; freely soluble in water. It contains about 14 per cent. of quinine sulph. and 13 per cent. of iron or 15 grains contain about 2½ grains of quinine and 2 grains of iron.

Dose—5 to 15 grs.—0·3 to 1 G.

Incompatibles of iron salts in general.—All vegetable preparations containing tannic and gallic acids form an inky mixture with ferric salts. These, however, can be clarified by adding a few drops of dilute phosphoric acid. Alkalies and their carbonates, lime water, calcium carbonate and magnesia and its carbonates give green precipitates with ferrous and brown precipitates with ferric salts, except the scale preparations which are compatible with them.

ACTION OF IRON AND ITS SALTS

External.—As antiseptics, iron salts are inferior to those of other heavy metals and are rarely used for this purpose. On raw surfaces and mucous membranes, they exert their **astringent** influence by coagulating the albumen of the discharge, and also in the tissues. Though they have no direct action on the blood vessels, yet they act as **hæmostatics.** They exert their hæmostatic action more powerfully by directly coagulating the protein of the blood and thus favouring normal clotting of the blood, which acts as a plug to the bleeding vessels. **Ferrous salts** combine with the albumen to form soluble salts and hence they are **less astringent** than the ferric salts, which form insoluble compounds with the albumen. The scale preparations, metallic iron and its preparations, the carbonates and phosphates of iron are the least astringent in their effect.

Internal.—*Alimentary Tract.*—Iron salts produce the same **astringent** effect in the mouth as on the raw skin. They have a styptic taste and cause blackness of the teeth and tongue, which is due to the formation of iron sulphide. In the stomach all iron salts are converted into chloride or combine with food to form albuminate which is again converted into chloride.

The ferrous salts in the stomach abstract the hydrochloric acid from the gastric juice and impair digestion. Ferric salts set the acid free after the formation of chloride to irritate the mucous membrane of the stomach and cause symptoms of indigestion. Scale preparations of iron do not ionize in the stomach, and therefore they do not impair digestion. The astringent effect of iron salts in the stomach is in proportion to the formations of ferric chloride. In the duodenum, the chloride coming into contact with alkaline and carbonates is converted into hydroxide carbonate, which remain in solution owing to the presence of organic matter. A portion from them is absorbed in the duodenum and jejunum. The unabsorbed portion reaches the intestine and is converted lower down into tannate and sulphide by the tannic acid of the food and the sulphuretted hydrogen generated in the intestines. Iron then is eliminated in the fæces which are coloured black. During its passage through the intestines, it exerts its **astringent action** and causes **constipation.**

Absorption, Storage and Excretion.—Iron is a necessary constituent of the body ; the total amount being about two to three grammes, *i.e.*, about 38 to 45 grains. It is mainly in the hæmoglobin of the blood. Owing to the continual destruction of the red blood corpuscles, the reduction of iron is, therefore, inevitable, but its supply is kept constant by our food which contains an adequate supply of iron. The iron in our food exists in organic compounds, and, as such, it must be getting absorbed into the system to feed the red blood corpuscles. But the opinions differ about the absorption of the inorganic compounds of iron. Some former investigators like Bunge and others, believed that the inorganic salts of iron were not absorbed into the system ; and they based their opinion on the fact that when iron salts are given by the mouth the quantity of iron in the fæces is greatly increased.

But there is no increase of iron in the excretion of urine or bile, which could only be there after absorption. This theory of theirs is only of historical importance now, for recent investigations have shown that the absence of increase over the normal quantity of iron in urine or bile could be accounted for by the retention of iron salts in the liver, and that their subsequent excretion through the intestinal mucous membrane causes the bulk of the iron thrown out with the fæces to increase. The absorption of inorganic iron is shown by killing the animals a few hours after giving iron preparations and staining their organs with special reagents which colour only the absorbed iron and leave the iron of hæmoglobin unaffected. By this histological method, it has been demonstrated that the inorganic iron granules are found in the epithelium of the upper third of the small intestine, in the liver, in the mesenteric lymph glands, spleen and in the cortex of the kidney. Iron, in whatever form it is taken internally, is absorbed through the epithelial cells of the intestines; it is taken up by the leucocytes of the mucosa, and carried along the lymphatics to the blood ; then it is stored up in the spleen, and is ultimately carried through the portal circulation to the liver, where it is built up into complex bodies—one of which is called ferratin—which are the precursors of hæmoglobin. Where the actual manufacturing of hæmoglobin takes place in the body is not yet definitely known ; but the red marrow of bones ultimately utilizes them to make red blood corpuscles. Any excess of iron remaining after its utilization is taken up by the blood and is excreted into the cœcum and large intestines by the epithelial cells to be eliminated outside the body as iron sulphide.

Blood.—In healthy persons, iron has very little action on the blood. In anæmic subjects the continued ingestion of iron causes a notable increase in the hæmoglobin percentage and later on it increases the number of red blood corpuscles and acts as a hæmatinic.

Tissues.—Iron has no specific effect on the tissues and the organs in which it is stored up. With the increase of the quality and quantity of red blood corpuscles more oxygen is carried to the tissues and the feeling of tone and vigour is increased. It indirectly leads to an improvement in all the functions in the body and thus acts as a **tonic.**

Kidneys and Bladder.—Iron salts are excreted by the renal cells. It, however, increases urea and other salts of urine. The quantity of iron excreted by the kidneys is so minute—about one milligramme a day—that it does not materially affect the secretion of the kidneys.

THERAPEUTIC USES

Externally, iron salts, particularly the ferric, are used as astringents and hæmostatics to check bleeding. Internally they are used in that form of secondary anæmia which is caused by loss of blood, malaria, lead poisoning, syphilis, etc., to enrich the quality of blood after the removal of the cause of anæmia. Iron is used in arsenical poisoning in the form of humid peroxide of iron which should be freshly prepared by mixing together three fluid ounces of Liquor Ferri Perchloridi and one ounce of Sodium Bicarbonate. Half an ounce should be given every ten to fifteen minutes. An insoluble arsenite is formed which is got rid of by a saline purge.

The qualities of Iron Preparations :—

1. The oxides and carbonates of iron are hæmatinics with very little astringency; but they may upset digestion by combining with hydrochloric acid of the gastric juice.
2. Compounds of iron with mineral acids are astringents and hæmostatics. They may liberate free acid and thus upset digestion.
3. Compounds of iron with vegetable acids are the weakest and least constipating preparations of iron. They may be given in small doses for a

long time. They can be given with alkalies except iron and quinine citrate.

4. Compounds of iron with active bodies such as arsenic, the iodide, the phosphate and the citrate of iron and quinine, combine the tonic effects of iron and the specific effect of the other ingredients.

Precautions to be taken in the administration of iron.—Iron may derange digestion even in healthy persons. It must not, therefore, be given during or after disease, until the digestion is improved as evidenced by a clean tongue. It must be given after meal. It is well to begin with the mildest preparations. It should not be given in fevers and should be cautiously administered to plethoric subjects or to those who are predisposed to apoplexy. The astringent preparations of iron are constipating and it is better to combine them with purgatives. If the administration of iron causes headache or indigestion, it is better to stop it.

MANGANESIUM

Potassii Permanganas.—Potassium permanganate; dark purple, irridescent crystals soluble in 20 parts of water.

Incompatibles.—It is readily deoxidised in the presence of organic matter. It forms explosive mixtures with glycerine, sugar, tannic acid, sulphur and other easily oxidisable substances. It is generally given as a pill made up with kaolin or paraffin.

Dose—1 to 3 grs.—0·06 to 0·2 G.

ACTION AND THERAPEUTIC USES OF POTASSIUM PERMANGANATE

External.—Potassium permanganate, in solid form or in concentrated solution, acts as an **irritant** and a mild caustic. In diluted solution, it acts as an **antiseptic,** because it readily gives off oxygen to organic substances, whereby it is itself reduced to manganese oxide, which occurs as a brown precipitate and may colour the skin. As it is immediately reduced by albumen, it cannot penetrate deeply. Malodorous products of decomposition together with the bacteria causing them are oxidised and destroyed by its use ; it, therefore, acts as **a deodorant** and **disinfectant.**

Potassium permanganate as a disinfectant is employed to wash hands, to disinfect stools and foul discharges, to wash utensils and bed-pans. In diluted solution it is used as an antiseptic for foul ulcers, for enemas in colitis and for injections in gonorrhœa, vaginitis, ozœna and uterine cancer. Permanganate is used as an antidote to snake bite. The bite is incised and the crystals of permanganate are rubbed in to have a cauterizing effect. Internally, it is used as a gargle in sore throat. Being an oxidising agent, it is used as an antidote in cases of poisoning by morphine and phosphorus.

Class III

CHROMIUM

Chromium Trioxidum.—Chromium Trioxide. *Synonym.*—Acidum Chromicum, Chromic acid, Chromic Anhydride. It occurs as dark red acicular, deliquescent crystals, soluble in water. It readily yields oxygen and in contact with even a small quantity of alcohol (90 per cent.), of ether, of glycerine and other organic substances, it is liable to cause sudden combustion and explosion.

ACTION AND THERAPEUTIC USES

Chromic acid is a powerful oxidising agent in addition to being a metallic oxide with poisonous action. In consequences of its oxidising power, chromic acid is a powerful **deodorant** and **disinfectant.** Applied to the skin in substance, it acts as a penetrating **caustic** without much pain. In dilute solutions, it acts as an **irritant.** It is not given internally, being a powerful gastro-intestinal irritant. It is used mainly as a caustic application to malignant growths, chancres and condylomata. In the form of solution, it has been used for its disinfectant properties to wash foul ulcers and sores. In very dilute solutions, it is used as a mouth-wash for ulcerations in the mouth and as an application to harden the skin and to prevent perspiration of the feet.

Class IV

HYDRARGYRUM

(Mercury)

1. Hydrargyrum.—Mercury or Quick Silver is a fluid silvery white metal which can easily be broken up into small globules. It forms two series of compounds : Mercurous where it is univalent and Mercuric where it is bivalent. In its metallic form, it is official in the following preparations :—

Dose—½ to 3 grs.—0·03 to 0·2 G. by mouth.
½ to 1 gr.—0·03 to 0·06 G. by intramuscular injection.

1. Hydrargyrum cum Creta. *Synonym.*—Grey Powder. Contains 33 per cent. of mercury with prepared chalk. Chalk is used to divide mercury in minute particles and to make it active by the formation of mercuric oxide.

Dose—1 to 5 grs.—0·06 to 0·3 G.

2. Injectio Hydrargyri.—Contains mercury incorporated in a fatty and oily base with a small quantity of camphor and creosote ; 10 minims contain about 1 grain of mercury.

Dose—5 to 10 ms.—0·3 to 0·6 G.

3. Pillula Hydrargyri. *Synonym.*—Blue Pill. Contains 33 per cent. of mercury rubbed up with syrup of liquid glucose, glycerine and powdered liquorice root.

Dose—4 to 8 grs.—0·25 to 0·5 G.

4. Unguentum Hydrargyri.—Contains 30 per cent. of mercury in suet and lard.

5. Unguentum Hydrargyri Dilutum. *Synonym.*—Blue ointment contains 10 per cent. of mercury.

6. Unguentum Hydrargyri Compositum. *Synonym.*—Scott's Ointment or Dressing. Contains about 12 per cent. of mercury together with camphor.

7. Unguentum Hydrargyri Nitratis Forte.—Strong Ointment of Mercuric Nitrate. *Synonym.*—Unguentum Hydrargyri Nitratis. Contains 6·7 per cent. mercury dissolved in nitric acid and diluted with lard and olive oil.

8. Unguentum Hydrargyri Nitratis Dilutus.—Diluted mercuric Nitrate Ointment. 20 per cent. in soft yellow paraffin.

2. Hydrargyri Oxidum Flavum.—Yellow Mercuric Oxide. A yellow heavy impalpable powder almost insoluble in water.

Oculentum Hydrargyri Oxidi.—Contains 1 per cent. of yellow mercuric oxide.

Oculentum Atropinæ cum Hydrargyri Oxidi.—Contain 1 per cent. of yellow mercuric oxide and 0·125 per cents of Atropine sulphate.

3. Hydrargyri Oxycyanidum.—Mercuric Oxycyanide. A white crystalline powder soluble in 18 parts of water. It contains about 22 per cent. of Mercuric oxide and 78 per cent. of mercuric cyanide.

Dose—$\frac{1}{12}$ to $\frac{1}{6}$ gr.—0·005 to 0·01 G. by intramuscular injections.

$\frac{1}{6}$ gr.—0·01 G. by intravenous injection.

4. Hydrargyri Perchloridum.—Perchloride of Mercury, Mercuric Chloride. *Synonym.*—Corrosive Sublimate. Heavy colourless crystals or white crystalline powder slowly soluble in 18 parts of water, readily in alcohol.

Incompatibles.—Alkalies and their carbonates, silver nitrate, albuminous solutions, soap, potassium iodide and other vegetable drugs containing tannic acid.

Dose—$\frac{1}{32}$ to $\frac{1}{16}$ gr.—0·002 to 0·004 G.

Liquor Hydrargyri Perchloridi.—0·1 per cent. solution in distilled water, or $\frac{1}{10}$ gr. in 110 ms. 60 ms. contain about 1 grain of mercuric chloride.

Dose—30 to 60 ms.—2 to 4 mils.

5. Hydrargyri Subchloridum.—Subchloride of Mercury; mercurous Chloride. *Synonym.*—Calomel. A dull white, odourless, tasteless powder, practically insoluble in water.

Dose—½ to 3 grs.—0·03 to 0·2 G. by mouth.
½ to 1 gr.—0·03 to 0·06 G. by intramuscular injection.

1. Injectio Hydrargyri Subchloridi.—Contains mercurous Chloride incorporated in a fatty and oily base with camphor and creosote. 20 minims contain 1 grain of mercuric chloride.

Dose—10 to 20 ms.—0·6 to 1·2 mils.

2. Lotio Hydrargyri Nigra. *Synonym.*—Black Wash. A suspension of mercurous oxide obtained by mixing mercurous chloride with lime water and glycerine. Strength 3 grs. to 1 fl. oz. Lotio Nigra is an example of intentional incompatibility.

3. Unguentum Hydrargyri Subchloridi.— 20 per cent. in simple ointment.

6. Hydrargyrum Oleatum.—Oleated Mercury, made by triturating 20 per cent. of yellow mercuric oxide in liquid paraffin and oleic acid.

Unguentum Hydrargyri Oleati.—Contains 25 per cent. of mercuric Oleate.

7. Hydrargyri Iodidum Rubrum.—Red Iodide of Mercury; a red crystalline powder feebly soluble in water but easily in a solution of Potassium Iodide.

Dose—$\frac{1}{32}$ to $\frac{1}{16}$ gr.—0·002 to 0·004 G.

Liquor Arseni et Hydrargyri Iodidi. *Synonym.*—Donovan's Solution. A clear pale yellow liquid containing 1 per cent. of each iodide.

Dose 5 to 15 ms.—0·3 to 1 mil.

8. Hydrargyri Ammoniatum.—Ammoniated Mercury. *Synonym.*—White Precipitate. An opaque white insoluble powder.

Unguentum Hydrargyri Ammoniati. *Synonym.*—White, precipitate Ointment; 5 per cent. in benzoated lard.

9. Phenylhydrargyri Nitras.—Phenylmercuric nitrate; white lustrous crystalline powder. It is slightly soluble in water.

10. Mersalylum.—Mersalyl. *Synonyms.*—Mercurgan, Salyrgan. It occurs in white, odourless, deliquescent powder with a bitter taste ; soluble in 1 part of water and in 3 parts of alcohol (95 per cent.). Insoluble in ether and in chloroform. It contains to 40·5 per cent. of mercury calculated with reference to the substance dried in a vacuum desiccator.

Injectio Mersalyli.—30 minims contain about 3 grains of Mersalyl and about 1½ grains of Theophylline which is added to inhibit the decomposition of the mercuric complex.

Dose—8 to 30 ms.—0·5 to 2 mils.

ACTION OF MERCURY AND ITS SALTS

Mercury is used medicinally in the form of preparations containing free mercury, and mercurous and mercuric compounds. In whatever form it is used, it exerts qualitatively the same action, but the intensity and rapidity of action are modified by the degree of solubility and the dissociation of the particular compounds used. The soluble mercuric salts act more powerfully than the insoluble mercurous salts. Of the soluble salts, the nitrate, sulphate and acetate of mercury are all dissociated more quickly than the chloride and yet their action as antiseptics is inferior to that of chloride. The high antiseptic power of chloride is due to its solubility in the lipoids—a property which is not possessed by other salts, and hence it penetrates bacteria more easily.

External.—The preparations of mercury are used either as antiseptics, irritants, antiparasitics or as absorbents.

Antiseptics.—All mercurials act externally as antiseptics and disinfectants, especially perchloride of mercury, which is a powerful poison to all forms of living cells and acts by precipitation of proteins and by forming complex compounds with protein molecules. Aqueous solution of 1 in 10,000 destroys micro-organisms and of 1 in 1,000 destroys their spores. The presence of albuminous matter in the fluid to be disinfected, diminishes its antiseptic and disinfectant action considerably, and this is prevented by adding 5 parts of hydrochloric or tartaric acid to one of perchloride of mercury. A solution of 1 in 1,000 is generally employed for disinfectant purposes. Phenylmercuric nitrate is a valuable germicide and fungicide.

Irritant.—The soluble salts of mercury are irritants, for the precipitate which they form with the protein molecule is more readily soluble in the fluids of the tissues than the albuminates of other heavy metals. It is for this reason that they have a very little astringent value ; but they have more penetrating **caustic action ;** for, every time a new and deeper surface is exposed to their action. The stronger solutions of perchloride, red iodide and acid solution of nitrate thus act as irritants and caustics. Insoluble salts of mercury, such as calomel and various mercurial ointments, have a feeble irritant effect but act as astringents, antiphlogistics and stimulants.

Antiparasitic.—Some of the preparations of mercury, especially the oleate, oxide, ammoniate, nitrate and perchloride, act as antiparasitics, destroying the animal and vegetable parasites which infest the skin. They also relieve itching.

Absorbent.—Metallic mercury or its salts are absorbed through the skin when applied or rubbed in the form of an ointment and lead to absorption of inflammatory products. The vapour can be absorbed through the mucous membrane of the lungs.

Internal.—*Alimentary Tract.*—In spite of the fact that externally different preparations of mercury have varying actions, nevertheless their action is similar after absorption. The preparations containing **free mercury** and **mercurous compounds** are not easily absorbed. They irritate the gastro-intestinal tract and act as **purgatives.** Their action is chiefly on the duodenum and jejunum and the contents of the intestines are hurried along before there is time for the bile to be reabsorbed into the portal circulation as it normally does. Hence these preparations increase the amount of bile evacuated without materially increasing its secretion. They, therefore, act as **indirect cholagogues.** Besides, mercury being a powerful antiseptic, it increases the purgative action of bile by preventing its decomposition. The motions are dark coloured on account of the presence of bile. They are soft and loose but not watery, since intestinal secretion is not much increased. Soluble salts of mercury have very little effect on the gastro-intestinal tract in therapeutic doses but their effect is more marked after absorption into the system. In large doses they act as gastro-intestinal irritants.

Absorption and Elimination.—Mercury, when taken by mouth, or inhaled in gaseous form, or in finely divided particles from all sites of its application, is absorbed into the system, and forms complex albuminate compounds which are insoluble in water but readily soluble in excess of albumen and sodium chloride. It circulates in the blood as oxyalbuminate and is deposited in the body, especially in kidneys, liver and spleen. It is excreted by every possible channel but the greater part by the intestines and kidneys. Its elimination is generally prompt and rapid. It is particularly so in cases of soluble salts of mercury. Insoluble salts are absorbed slowly and they take a longer time for elimination and when repeated doses are given, elimination fails to keep pace with absorption and the drug accumulates in the organs to produce symptoms of chronic poisoning with mercury.

Blood.—Mercury compounds circulate in the blood and influence it according to the dose and treatment carried out. In minute doses of short duration, it increases the quality and quantity of red blood corpuscles, which in turn brings out general improvement to increase the body weight, but if the treatment with small doses be continued long or if the dose given be large, the blood loses its fibrin and causes destruction of the red cells with consequent anæmia. Mercury checks the migrations of the white blood cells and acts as an **antiphlogistic.** It is believed to diminish the alkalinity of the plasma and to increase the water contents of the blood. This is of great importance in connection with the effect of the drug on the kidneys. The diminished alkalinity of the plasma is probably due to the increased formation of lactic acid.

Kidneys.—Insoluble salts given by mouth and soluble salts injected subcutaneously act during excretion as diuretics. This was attributed to the stimulation of the renal cells, but recent investigations point out the fact that it is due to the hydræmic condition of the blood, which leads to increased glomerular filtration and prevention of reabsorption of water from the renal tubules. **Diuretic effect** is more marked when there is accumulation of fluid in the body. Large doses of soluble mercurial salts cause inflammation of the kidneys and provoke albuminuria.

Toxicology.—Besides the effects of mercury mentioned above, the toxicology of mercury is important. The effects of acute poisoning by an overdose of mercury are manifested in the corrosive irritation of the gastro-intestinal tract. It causes burning pain in the mouth, throat and stomach; nausea and vomiting with bloodish shreds of mucous membrane; diarrhœa, violent tenesmus; dysenteric stools with evidence of collapse—small weak thready pulse; shallow rapid respiration; cold clammy sweats and sunken eyes. The voice may sink to a husky whisper and the face is anxious and pinched, denoting the pain which the patient suffers. This is accompanied by the suppression of urine.

Hydrargyrism or Mercurialism.—In chronic poisoning the local effects of acute poisoning are absent; but continued absorption of small quantities of mercury produces a series of symptoms known as Hydrargyrism. The symptoms are mainly due to irritation caused by mercury during its excretion. The earliest symptom to appear is the metallic taste in the mouth followed by salivation and fœtid breath. There is swelling of the gums, dyspepsia and diarrhœa. In spite of these warnings of the symptoms, if the administration of mercury is continued, ulceration of the mouth and tongue supervenes. The teeth get loosened in the spongy gums and fall out. In some cases, there occurs necrosis of the jaw. At later stages, skin eruptions may occur and the patient becomes pale, cachectic and emaciated. The kidneys get affected ; but not in the same degree as in the case of acute poisoning. The effects on the nervous system are seen in muscular tremors, especially affecting the muscles of the face and hand, and shooting pain in the limbs. There is mental irritability, cardiac depression and exhaustion. This weakened condition of the body serves as a favourable field for the tuberculosis of the lungs, which is often the ultimate cause of death.

Tolerance.—Age, sex and idiosyncrasy greatly modify the action of mercury. Children and infants bear mercury better than adults ; and males better than females. It is not well tolerated by persons suffering from chronic disease of kidneys, scrofula and scurvy. Certain persons are very susceptible to this drug ; even the smallest dose is quite sufficient to start salivation in them.

Specific action of mercury.—Mercury is a specific for syphilis, especially in the primary and secondary stages of the disease. It acts by destroying the causal micro-organism, Spiro-chæta Pallida, through the precipitation of proteins. In this respect, mercury shows a selective action. Its specific power towards the syphilitic parasite is much greater than towards other blood parasites.

Administration of mercury.—Mercury can be administered for this purpose in a variety of ways, of which the following are the most important :—

1. *By ingestion.*—The preparations to be used by this method are many. It is a most convenient method, but it is apt to produce alimentary disturbance and is less efficacious than innunction. The preparations commonly used are Blue Pill, Grey Powder, and Calomel.

2. *By innunction.*—Mercury in the form of blue ointment, oleate or liniment is rubbed into the skin for its

absorption. The surfaces chosen for rubbing, in definite daily rotation, are the inner side of the thigh, the axilla, the calves and the abdomen, where the skin is soft and thin. This is the method of choice in the treatment of young children. The metal is absorbed by the sebaceous glands and this absorption is more rapid, if the basis of the ointment is animal fat as in blue ointment. This method minimises the digestive disturbances that mercury is apt to set up; but it is disagreeable, and the amount of absorption by the skin is uncertain.

3. *By injection.*—Both the soluble and insoluble compounds of mercury are employed. As regards promptness of action, accuracy in dose and ease of employment, it is a method of choice, but it has its drawbacks. Subcutaneous injections of mercuric preparations are painful and liable to produce abscesses. Intravenous injections are more dangerous and are liable to produce toxic symptoms and induce nephritis. Mercury is, therefore, only injected intramuscularly. The various preparations are so used, a suspension of mercury in a mixture of lanoline and oil being a favourite preparation. The injections are usually given into the gluteal muscles, weekly for several weeks.

4. *By rectum.*—Mercury in the form of suppository is used for its local as well as general action.

The administration of mercury by fumigation, inhalation and bath was in vogue, but it has not survived the test of time and is rarely used now.

THERAPEUTIC USES

Metallic mercury in a finely divided form is given internally in the form of Hydrargyrum cum Creta and Pillula Hydrargyri, as a purgative in various conditions. Hydrargyrum cum Creta is given to children in vomiting and diarrhœa. It is a convenient preparation in small doses, for a course of mercury in syphilis. Blue pill is used as a purgative at bed time in biliousness and in hepatic disorders and is generally followed by a saline purge in the morning. Mercury ointment is used as an antiphlogistic over inflamed parts. Liniment and plaster are used as a resolvent in chronic inflammation of joints and abdomen. Mercuric Chloride in the form of lotion (1 in 10,000) is used as an antiseptic and disinfectant in the treatment of wounds. In stronger solution (1 in 200), it is used as a spray or wash in diphtheria. Liquor Hydrargyri Perchloridi is given for the treatment of syphilis, either by the mouth, or by subcutaneous or by intramuscular injection. Calomel is used externally as a stimulant, disinfectant and antiseptic. It is dusted on the syphilitic ulcers and in external diseases of the eye. Internally, it is used as a purgative and in small doses as a remedy for syphilis. It forms a useful adjuvant to other diuretics in diseases of the heart. Calomel is also given in chronic skin diseases, especially those of syphilitic or gouty origin.

The oxides, iodides, ammoniated mercury and oleate of mercury are used externally for the relief of syphilitic sores, ulcers and skin diseases. They are of great value in parasitic skin affections and as absorbents of chronic inflammatory and glandular swellings. Mercuric nitrate solution is used as a caustic in lupus, other limited growths and ulcers of the skin.

Precautions.—Mercury should not be given to weak and anæmic persons. It should be cautiously given to persons suffering from phthisis, renal disease and even syphilis. Patients undergoing a course of mercury should be carefully nourished and kept warm. To obviate salivation, teeth should be regularly cleaned and mouth wash of potassium chlorate be used.

Treatment of poisoning with mercury.—In acute poisoning, the stomach should be washed and tannic acid, milk and the white of egg be administered. In chronic poisoning the excretion of the metal is procured by hot baths and by administration of Potassium Iodide.

GROUP IV

METALLOIDS

Bismuth, Antimony, Arsenic

In the actions of these metals, their resemblance to those of heavy metals diminishes as we proceed from bismuth to arsenic; but their action on the metabolic function becomes more pronounced in the same order. Bismuth and antimony are grouped by some under heavy metals.

BISMUTHUM

(Bismuth)

1. **Bismuthum Præcipitatum.**—Precipitated bismuth. It contains not less than 98·5 per cent. of metallic bismuth. It occurs as a dull grey powder, insoluble but diffusible in water.

Dose—2 to 3 grs.—0·12 to 0·2 G.

Injectio Bismuthi.—15 minims contain about 3 grains of precipitated bismuth.

Dose—8 to 15 ms.—0·5 to 1 mil. by intramuscular injection.

2. **Bismuthi Carbonas.**—Bismuth oxycarbonate, a heavy white powder insoluble in water. Contains about 90 per cent. of bismuth oxide.

Dose—10 to 30 grs.—0·6 to 2 G.

Trochiscus Bismuthi Compositus.—Contains 0·15 G. (2½ grs.) of oxycarbonate, together with magnesium and calcium carbonates in a basis scented with oil of rose.

3. **Bismuthi Salicylas.**—Bismuth salicylate or bismuth oxysalicylate. A nearly white amorphous or crystalline powder insoluble in water, alcohol and glycerine. Contains about 66 per cent. of bismuth oxide.

Dose—10 to 30 grs.—0·6 to 2 G.

Injectio Bismuthi Salicylatis.—20 minims contain about 2 grains of Bismuth Salicylate.

Dose—10 to 20 ms.—0·6 to 1·2 mils. by intramuscular injection.

4. Bismuth et Sodii Tartras.—Sodium Bismuthyl Tartrate. *Synonym.*—Bismuth Sodium Tartrate. A white powder or yellowish scales containing 35 to 42 per cent. of Bismuth. Soluble in less than 1 part of water.

Dose—1 to 3 grs.—0·06 to 0·2 G. by intramuscular injection.

5. Bismuth Oxychloridum.—Bismuth Oxychloride. *Synonym.*—Bismuth Subchloride. An amorphous or finely crystalline powder insoluble in water, soluble in dilute hydrochloric acid.

Dose—10 to 30 grs.—0·6 to 2 G. orally.

1½ to 3 grs.—0·1 to 0·2 G. by intramuscular injection.

Injectio Bismuthi Oxychloridi.—30 minims contain about 3 grains of Bismuth Oxychloride.

Dose—15 to 30 ms.—1 to 2 mils. by intramuscular injection.

6. Bismuthi Subgallas. *Synonyms.*—Dermatol. Bismuth Oxgallate, Basic Bismuth Gallate. It occurs in a yellow, tasteless, insoluble powder.

Dose—10 to 30 grs.—0·6 to 2 G.

7. Emetinæ et Bismuthi Iodidum, see Ipecacuanha.

ACTION OF BISMUTH SALTS AND THEIR PREPARATIONS

External.—Salts of Bismuth dusted on raw surfaces protect them from irritation of air and dirt and act as mild **astringents, sedatives** and **antiseptics.**

Internal.—*Alimentary Tract.*—There, too, bismuth salts have the same astringent action as on the raw surfaces. They act mechanically, by forming an adhesive coating over the mucous membrane of the stomach and preventing its irritation from food and secretions and also by absorbing toxins. Lower down in the intestine, they have the same action and diminish the stimulation of the bowels and consequently peristaltic action. They have thus a slight **astringent** action. They are also gastro-intestinal **antiseptics.** Bismuth subnitrate is the most powerful in that direction, for in contact with water, it splits up into bismuth oxide and nitric acid. Bismuth oxide in the intestine is converted into bismuth sulphide and leaves the body colouring the fæces black; while nitrous vapour which is liberated acts as an **antiseptic.**

Absorption and Elimination.—The insoluble salts of bismuth are absorbed in minute quantities through the gastro-intestinal mucous membrane and do not produce any systemic effect. Considerable absorption, however, may take place when applied to raw surfaces, and bismuth, like other heavy metals, is stored up in the liver, spleen and nerves. The unabsorbed portion together with that which is excreted by the cæcum and the neighbourhood, is thrown out with the fæces. It is also excreted, to a smaller extent, by the kidneys.

Chronic poisoning.—The application of a large quantity of bismuth for a long time to raw surfaces produces symptoms similar to those of poisoning by mercury. The first manifestation is the formation of a blue line on the gums. Later on, there is ulceration and patchy discoloration of the mouth and throat, accompanied by salivation, loosening of teeth, diarrhœa and nephritis.

Specific action.—Bismuth compounds have recently been shown to have value in the treatment of syphilis and other spirhœtal infections. It is used in suspension of salicylate or of metal itself; and is administered intramuscularly. It is said to be of value in manifestations which are resistant to both mercury and arsenic.

THERAPEUTIC USES

Bismuth salts are used externally in the form of powder, lotion or ointment, in acute skin diseases and in the treatment of wounds. It is used as snuff for the cure of cold. Suspended in mucilage, it is used as an injection for gonorrhœa.

Internally, bismuth carbonate is used to allay irritable and painful gastric trouble. The subgallate is used principally for its local astringent and protective action on ulcerative colitis. It is also used as an antiseptic dusting powder. Bismuth salicylate is mainly used as a sedative and antiseptic in diarrhœa and dysentery. Bismuth meal of Bismuth Carbonate and bread crumbs suspended in mucilage is used for diagnostic purposes, in X-ray examination of the gastro-intestinal tract, as the penetration of X-rays is obstructed by bismuth salts. Injections of metal bismuth and Bismuth Salicylate are used for the cure of syphilis.

ANTIMONIUM

(Antimony)

1. **Antimonii et Potassii Tartras.**—Potassium Antimony Tartrate. *Synonyms.*—Antimonium Tartratum ; Tartar Emetic. Occurs in white granular powder or colourless transparent crystals soluble in 17 parts of water.

Incompatibles.—Tannic and Gallic Acids, Alkaline Carbonates, Salts of most metals, Lead Acetate and Albumen.

Dose— **$\frac{1}{32}$ to ⅛ gr.—0·002 to 0·008 G.** by mouth.
½ to 1 gr.—0·03 to 0·06 G. emetic dose.
½ to 2 grs.—0·03 to 0·12 G. by intravenous injection.

2. **Antimonii et Sodii Tartras.**—Sodium Antimony Tartrate. Occurs in colourless transparent or white scales or powder. It is odourless and hygroscopic, soluble in 1·5 parts of water.

Dose—Same as Antimonii et Potassii Tartras.

3. **Stibophenum.** *Synonym.*—Fouadin. Stibophen is an organic salt antimony. It contains about 16·0 per cent. of trivalent antimomy, and about 17·0 per cent. of sulphur. It occurs in colourless crystals and is readily soluble in cold water.

Dose—1½ to 5 grs.—0·1 to 3 G, by intravenous injection.

ACTION OF SALTS OF ANTIMONY

External.—Antimonial compounds are powerful **irritants.** Tartar emetic when applied to the skin as ointment or otherwise causes redness and itching followed by eczema and if its application is continued long, it produces pustular eruptions due to the formation of an insoluble yet more irritant salt by the acid secretion of the sweat glands.

Internal.—*Alimentary Tract.*—For internal administration, Tartar emetic is the salt generally used. It acts as an **irritant** to the gastro-intestinal tract, the degree of irritation depending on the dose used. In small doses, it produces a sense of warmth and soreness in the stomach. In large doses (2 to 3 grs.) it acts as an **emetic** by direct action on the stomach. If introduced intravenously, it also acts as an emetic. This led to the supposition that it might be acting by central action also, but this supposition is now discarded ; for, the venous injection, instead of acting promptly as an emetic, takes a longer time to act than when given by the mouth, and it does not act as an emetic, till it is excreted into the stomach. The vomiting caused by the tartar emetic is generally more prolonged and is accompanied by great depression with concomitant symptoms of nausea, salivation, increase of bronchial secretion, perspiration and increased rapidity of both pulse and respiration. If it fails to act as an emetic, it acts as an intestinal irritant with symptoms resembling those of arsenical poisoning, namely colicky pains, purging, cramp of legs, intense thirst and collapse : symptoms which may be mistaken for those of cholera.

Absorption and Elimination.—Even the most soluble salts of antimony are absorbed slowly into the system and remain deposited in the liver for a long time. They are eliminated slowly yet unchanged, by the kidneys, stomach and intestine, and in small quantities in the bile, from the skin and in the milk.

Circulatory System.—It is a **cardiac depressant** acting directly on the muscles of the heart and reducing its force and frequency. It dilates the blood vessels by its depressing action on the vaso-motor centre, and causes a fall in the blood pressure, which is further assisted by relaxation of the arteries due to the paralysing effect of antimony salts on their muscular coat.

Respiratory System.—The respiratory system is first stimulated and then depressed. Inspiration becomes short and jerky and expiration becomes prolonged and sighing, and finally respiration becomes slow and irregular. In sub-emetic doses, antimony increases the bronchial secretion and acts as an **expectorant.**

Temperature.—Antimony in large doses causes a considerable fall in temperature by sweating due to its remote local effect on the sweat glands, by depressing circulation and by diminishing metabolism.

Nervous System.—It is a powerful depressant to the spinal cord affecting directly its sensory and motor tracts. It depresses the brain to a lesser extent and produces headache, vertigo and lassitude.

Remote Effects.—Antimony during the process of excretion irritates the channels of excretion by its passage through them and causes increase in their secretion and thus it acts as an **emetic, expectorant, diaphoretic, diuretic, and a cholagogue.**

Specific action.—In recent years, it has been discovered that antimony compounds, when given intravenously, have a powerful trypanocidal action. Its range of parasiticidal activity is also taken advantage of in the treatment of Leishmaniasis (Kala-azar) and Schistosomiasis (Bilharzia infection).

THERAPEUTIC USES

Antimony tartrate is given as an expectorant in the early stages of bronchitis, in chronic skin diseases and in fevers.

Owing to its depressing action, it is also used as an antiphlogistic in the early stages of respiratory affections. In the form of intravenous injection, it is given in the treatment of Kala-azar, and the salt preferred is Sodium Antimony Tartrate which is less toxic and more soluble than antimony tartrate. As an emetic, it is generally given in the form of antimony wine. It is sometimes given with or without opium as a sedative in the delirium and insomnia of fevers.

Suraminum. *Synonyms.*—Antrypol, Moranyl, Germanin, Bayer 205. It is a complex urea compound. It occurs as a white or cream coloured powder, with alkaline taste, freely soluble in water.

Dose—15 to 45 grs.—1 to 3 G. by intravenous injection.

THERAPEUTIC USES

Suramin also is used as a trypanocide and is effective against *T. rhodesiense* and *T. gambiense.* It is used in the treatment of sleeping sickness. It may produce dermatitis, nephritis and optic neuritis.

ARSENIUM

(Arsenic)

Chemistry.—Arsenic is both *Trivalent* and *Pentavalent.*

The trivalent ..	Inorganic: Arsenious acid and the arsenites.
	Organic: Sulpharaphenamine.
The Pentavalent.	Inorganic: Arsenic acid and the arsenates.
	Organic: Acetarsol and Tryparsamide.

In the trivalent the arsenic is unsaturated and has powerful activity and toxicity much greater than that in the pentavalent. According to most authorities, the trivalent form only is physiologically active and all pentavalent must be converted into this before exhibiting toxic or therapeutic activity.

1. Arseni Trioxidum.—Arsenic Trioxide. *Synonyms.*—Acidum Arseniosum ; Arsenious Anhydride ; Arsenic ; Arsenious Acid ; White Arsenic. It occurs in opaque white, glassy or porcelain-like masses or amorphous, heavy, white powder sparingly soluble in water, easily soluble in alkalies and glycerine.

Incompatibles.—Lime water, Magnesium, Salts of iron.

Dose—$\frac{1}{60}$ to $\frac{1}{12}$ gr.—0·001 to 0·005 G.

Liquor Arsenicalis. *Synonym.*—Fowler's Solution. It contains 1 per cent. of arsenic trioxide in the solution of potassium hydroxide and neutralized with dilute hydrochloric acid. It is a clear liquid with a saline taste.

Dose—2 to 8 ms.—0·12 to 0·5 mil.

2. Arseni Triiodidum.—Arsenic Triiodide. *Synonym.*—Arseni Iodidum. Orange coloured crystals or powder soluble in 18 parts of water.

Dose—$\frac{1}{16}$ to $\frac{1}{4}$ gr.—0·004 to 0·016 G.

Liquor Arsenii et Hydrargyri. *Synonym.*—Donovan's Solution (see Mercury, page 174).

ACTION OF ARSENIC AND ITS COMPOUNDS

External.—Arsenic has no action on the unbroken skin ; but applied to raw and mucous surfaces, it acts as an **irritant,** and in concentrated solution as a **caustic.** Its caustic action is not due to precipitation of proteins as in heavy metals but is due to slow destruction of a living tissue. Arsenic has no caustic action on dead tissues, but it mummifies them. This is the point of difference between the caustic action of arsenic and of acids and other drugs which affect living and dead tissues alike.

Internal.—*Alimentary Tract.*—In **minute doses,** arsenic stimulates gastric mucous membrane and acts as a **stomachic.** In **large doses,** it acts as a gastro-intestinal **irritant.** This may be partly due to the local effects of stomach after arsenic and partly to the excretion of arsenic into the absorption ; for, this effect is also seen even when injected subcutaneously.

Absorption and Elimination.—Arsenic in solution is absorbed readily from raw and mucous surfaces. It is deposited in large quantities in the liver, spleen and kidneys, but the traces of arsenic are also found in all organs even in the hair and in the bones. It is eliminated by all secretions and excretions, but principally in the urine intermittently, over a considerable period.

Blood.—The action of arsenic on the blood is still obscure. It is said to lessen the number of red blood corpuscles but not the total amount of hæmoglobin. It is used as a routine measure in various forms of anæmia. In pernicious anæmia, it increases the number of young red cells while the matured ones are lessened. The action of arsenic is more marked after hæmorrhage. The blood regenerates more quickly and the number of red blood corpuscles rises more quickly than the hæmoglobin.

Circulatory System.—Arsenic has no direct action on the circulation. Its principal effects, when continued long, are exerted upon the blood vessels and especially on the capillaries which are dilated through the peripheral vasomotor depression. As a result of this dilatation, there occurs stasis of blood, which leads to the escape of fluid from the capillary walls into the surrounding connective tissues and causes puffiness under the eyelids and œdema.

Respiratory System.—It is not much affected by medicinal doses though it is believed that persons habituated to the use of the drug do not show respiratory distress under exertion.

Nervous System.—In medicinal doses, arsenic has no direct action on the nerves, but when imbibed long, symptoms of peripheral neuritis occur. This may affect the sensory nerves causing various disturbances of sensation, and also the motor nerves producing paralysis of voluntary muscles, the first manifestation of which is seen in the loss of the knee jerk.

Metabolism.—The mode of action of arsenic on the tissues is not well understood. It affects the general metabolism of all organs and tissues by increasing katabolism on the one hand and deficient oxidation on the other. It thus alters their activity in such a way that it induces general nutrition to act as an alterative and tonic. Carbo-hydrate metabolism is stimulated, but owing to inefficient oxidation lactic acid appears in the blood to diminish its alkali reserve. It inhibits the formation of glycogen in the liver and also prevents desaturation of fat, which accumulates in the system to cause fatty infiltration and degeneration of protoplasm. This change is particularly found in the liver, kidneys and in muscles of the heart and blood vessels. Protein metabolism is increased but it being imperfect, leucin and tyrosin may be found in urine in association with urea and uric acid. There is also marked increase in the excretion of ammonia which is formed by the liver to protect the alkali reserve of the plasma. The activity of the bone marrow is stimulated due to the increased vascularity, and the compact tissue increases at the expense of the medullary.

Skin.—Arsenic in smaller doses has a nutrient effect on the skin. It increases the subcutaneous fat, makes the skin glossy and improves the complexion. In large doses, it gives rise to itching and eruptions and temporary patchy pigmentation of the skin called the arsenical melanosis, which forms one of the symptoms of chronic poisoning by arsenic.

Tolerance.—Toleration of arsenic can be established by swallowing it in increasingly large doses. But the arsenical tolerance cannot be explained on the "slow absorption and quick excretion" basis, for the excretion of arsenic is also slow. It has been suggested that the local changes induced by the irritant action of arsenic in the alimentary canal are responsible for its tolerance by preventing absorption. Another explanation suggested is that the leucocytes by which arsenic is absorbed, convert it into non-toxic compounds which are excreted.

Toxicology of Arsenic.—In acute poisoning by large doses the symptoms supervene after about half an hour of its ingestion. The symptoms are not manifested immediately. They only occur when the arsenic is in the process of excretion. There is severe gastro-intestinal irritation, and its manifestations :—nausea, sickness, epigastric pain and tenderness, followed by vomiting tinged with blood, and profuse watery diarrhœa with shreds of mucous membrane in it. The secondary symptoms due to loss of fluid and dilatation of blood vessels supervene. There is intense thirst, diminution or suppression of urine, low blood pressure and collapse with coldness and pallor of skin and rapid feeble pulse. The symptoms may continue from a few hours to many days, according to the dose. If death occurs speedily, it may be due to nervous influence or cardiac depression. If the dose is below the lethal or is largely vomited, the patient may recover completely or may pass into the stage of chronic arsenical poisoning.

The treatment of acute arsenical poisoning consists in washing out the stomach, repeatedly administering fatty substances such as castor oil, which delay the absorption of the poison and protect the exposed surfaces. The chemical antidotes are magnesia and freshly prepared humid iron. These form insoluble compounds and must be given in repeated doses. The patient's vitality must be kept up by keeping him warm and by repeated injections of alcohol.

Chronic Poisoning.—Early symptoms of saturation or toxic action of arsenic are redness, inflammation, itching and puffiness of the eyelids and conjunctiva, and the catarrhal condition of the upper air passages with symptoms of coryza. Eruptions in the form of papules, vesicles or erythema appear on the skin. It becomes pigmented in brown circumscribed patches. Later on, sensation and motion are disturbed from peripheral neuritis. Muscles are atrophied and degenerated. There are repeated attacks of dyspnœa due to the weakened condition of the heart. Dropsy and general emaciation due to the fatty degeneration of the tissues and internal organs ultimately prove fatal. If the poisoning of the system by arsenic is stopped, recovery may be complete but not if the muscles have been degenerated.

THERAPEUTIC USES

Arsenic acid, diluted with flour or charcoal, is used as a caustic for destroying lupus, condyloma and epithelioma. Combined with morphine or cocaine, it is used to kill a nerve before filling a tooth. Internally it is given in chronic skin diseases, such as psoriasis and chronic eczema. Here it acts by improving the condition of the skin. Arsenic benefits some cases of pernicious anæmia. It is also given in some nervous diseases, in cardiac weakness, gout, chronic rheumatism and gastric catarrh. In malaria and in diseases due to trypanosomes, it is believed to act by destroying the infective agents. Liquor Arsenicalis is commonly used for administering arsenious acid. It is an alkaline preparation and should not be given with an acid solution. Ferri Arsenas combines the effects of iron and arsenic acid and is given in anæmia and chronic skin diseases.

ORGANIC COMPOUNDS OF ARSENIC

SULPHARSPHENAMINA

(Sulpharsphenamine)

General Remarks.—The term " Organic compounds of Arsenic " is applied to those compounds of arsenic where arsenic in its trivalent or pentavalent form is linked up with side chains or radicals of hydrocarbons of aliphatic (Fatty) or aromatic (Benzol) series. The compounds so formed are principally used for combating infection of blood from parasites of sleeping sickness (Trypanosomes), Syphilis, Spirilosis (Relapsing fever) and other parasitic diseases. The parasiticidal treatment of infections by metals in organic combination is known as Chemo-therapy. The organic compounds of arsenic differ from the inorganic salts in that, a much larger dose of arsenic could be introduced into the system than is otherwise possible, as the metal in them is in non-ionic form. It is stored up in the tissues and is liberated in the organism readily with the gradual production of ordinary arsenic effects. The whole of the organic molecule may act as such or may get split up in the body, the nucleus determining its intensity and the organic radical its penetrating power. These compounds are practically inert outside the body, having no action on the parasites in a test-tube experiment; but inside the body all the organic arsenicals combine with certain proteins to form one or more proteo-arsenical compounds which prove more toxic to the parasites than to the individual infected by them; that is to say, they become more parasitotrophic and less organotrophic. Like the inorganic salts they are slow in their absorption and elimination, and are, therefore, cumulative in effect. Given by the mouth the organic molecules are likely to undergo toxic cleavage in the digestive tract; they are, therefore, administered by intravenous or intramuscular injections.

1. **Sulpharsphenamina.**—Sulpharsphenamine. *Synonym.*—Sulpharsenobenzene, Salvarsan, 606. It occurs in requisite doses in sealed glass tubes as a yellow dry powder soluble in water. The addition of Sulphur to Arsenobenzene is said to reduce its toxicity. It contains about 20 per cent. of arsenic.

Dose—1½ to 10 grs.—0·1 to 0·6 G. by subcutaneous or intramuscular injection.

2. **Neoarsphenamina.**—Neoarsphenamine. *Synonyms.*

—Novarsenobenzol, Novarsenobenzene, 914. It is distributed in sealed glass tubes as a yellow dry powder soluble in water. It contains about 20 per cent. of arsenic.

Dose—2½ to 14 grs.—0·15 to 0·9 G. by intravenous injection.

3. **Acetarsol.** *Synonyms.*—Acetorsone, Stovarsol, Kharophen, Spirocid. A white crystalline powder containing 27·0 to 27·4 per cent. of arsenic. Insoluble in cold water, in alcohol (95 per cent.) and in dilute acids ; moderately soluble in boiling water and soluble in dilute alkalies.

Dose—1 to 4 grs.—0·06 to 0·25 G.

4. **Tryparsamidum.**—Tryparsamide. *Synonym.*—Tryparsonum. A colourless, odourless, crystalline powder. Containing 25·1 to 25·5 per cent. of Arsenic inorganic combination. It is a pentavalent arsenical soluble in water. insoluble in alcohol (95 per cent.), in ether and in chloroform;

Dose—15 to 30 grs.—1 to 2 G. by subcutaneous, intramuscular or intravenous injection.

ACTION AND THERAPEUTIC USES

Sulpharsphenamine and its various modifications are used mainly for the cure of syphilis in its various stages and manifestations. It is given in a course of 4 to 6 injections at the interval of a week or a fortnight. If there be any toxic manifestations of arsenic, the injections are suspended or the dose is reduced. After an intravenous injection, it remains in the blood for about five or six hours, and is then stored in the tissues, particularly the liver and bone marrow, and is then gradually excreted mainly in the urine ; and the excretion may continue for 20 to 25 days.

These compounds are also found to be useful in other protozoal diseases, such as rat-bite fever, relapsing fever, sleeping sickness and broncho-spirochætes.

Acetarsol is commonly used for chronic amœbic dysentery, in malaria and in the early treatment of syphilis. Tryparsamide is largely used in the treatment of neuro-syphilis. It has no effect on primary or secondary syphilis, It is also used in some forms of Trypanysomiasis. It is liable to produce optic atrophy.

Though these compounds of arsenic are said to be the least toxic, yet they sometimes manifest their toxic effects, which may be acute or chronic. **Acute poisoning** occurs within four hours of its administration and the chronic form develops gradually after repeated injections. The symptoms of acute poisoning are more common with salvarsan than with its other modifications, and are of the type of a vasomotor syndrome which resemble in some respects anaphylactic shock. There is vascular dilatation, fall of blood pressure, rigor followed by rise of temperature, vomiting, cyanosis, faintness, palpitation and oppressive feeling in the chest, skin eruptions, swelling of the lips and tongue and albuminuria. These effects are not due to a toxic action of arsenic but to an alteration in the blood proteins or perhaps agglutination of the red blood corpuscles resulting from the colloidal nature of the salt injected. These symptoms may be prevented by injecting atropine, or mitigated by injection of the solution of adrenalin or of bicarbonate of soda.

In chronic poisoning, disorders of the hepatic functions are the most common. The various skin eruptions also occur, the most frequent being urticaria and erythema; sometimes, there occurs exfoliative dermatitis which often proves fatal.

The toxic symptoms may be due to some error in the manufacture or administration of the drug; to a faulty technique in the preparation of the solution, or the solution remaining exposed to air for a long time; they may again be due to the solution escaping into the surrounding tissue while injecting into a vein or on account of the rate of injection being not carefully timed; or they may be due to the presence of a disease in which it is contra-indicated. They may also be due to idiosyncrasy on the part of the patient.

The contra-indications are:—Great weakness, advanced age, degeneration of the central nervous system, diseases of circulation and respiration, albuminuria, gastric ulcer and chronic intoxication, as alcoholism.

GROUP V

HALLOGENS

Chlorine, Bromine, Iodine

General Remarks.—Being derived from the sea, these elements are named Hallogens (Helost—Sea).

Chlorine is obtained from sea-salt; Bromine, from sea-water; and Iodine, from sea-weeds. They are all volatile. At ordinary temperature chlorine is a gas, bromine a liquid and iodine a solid. These unite with metals to form salts. They have a great affinity with hydrogen and hence they are powerful decomposers of chemical and many organic matters. They are, therefore, used as disinfectants and deodorants. Applied to the skin, they are irritants.

CHLORUM

(Chlorine)

1. **Calx Chlorinata.**—Chlorinated Lime. *Synonym.*—Bleaching powder. It is a white or greyish-white powder with the odour of chlorine; partly soluble in water. It is obtained by exposing slaked lime to the action of chlorine and it consists mainly of a mixture of calcium hypochlorite and calcium chloride. It contains not less than 30 per cent. of available chlorine.

Liquor Sodæ Chlorinatæ Chirurgicalis. *Synonym.*—Dakin's Solution. It is a mixture of equal parts of chlorinated lime, sodium carbonate and boric acid in distilled water. If contains not less than 0·5 and not more than 0·55 per cent. of available chlorine. It is kept in a well closed container protected from light and stored in a cool place.

2. **Chloramina.**—Chloramine. *Synonym.*—Chloramine T. Para-toluene-sulphone-chloroamide. Chlorazene. It occurs in faintly yellow crystals or crystalline powder with an odour of chlorine, and is soluble in 7 parts of water, 2 parts of boiling water. It should be preserved in a well closed glass container, protected from light and stored in a cool place.

ACTION OF CHLORINE AND ITS COMPOUNDS

External.—Chlorine as well as its compounds are powerful disinfectants and deodorizers in the presence of water, acting by virtue of its great affinity with hydrogen, the oxygen liberated from water acting as a **germicide.** It may also act as an **antiseptic** or **disinfectant** by uniting with the proteins of the bacteria, but as it combines with the proteins of tissues also, its power as a disinfectant is soon lost. For effecting sterilization of infected wounds the action of chlorine must, therefore, be continuous and is best obtained by frequent saturation of wounds with hypochlorite solutions which liberate chlorine in contact with organic matter. Chlorine vapour, if confined, acts as an **irritant** to the skin.

Internal.—Inhalation of chlorine gas causes irritation of the eye, nose and respiratory passages. In the stomach, it is converted into chlorides and has very little action.

THERAPEUTIC USES

Chlorine in the form of bleaching powder is used as a disinfectant for sanitary purposes and for sterilizing drinking water. In the form of gas evolved from common salt and sulphuric acid, it is used to disinfect rooms and holds of ships. Chlorine water in the form of Liquor Sodæ Chlorinatæ is used as a wash for foul ulcers. Hypochlorus acid and hypochlorites, which evolve chlorine slowly in contact with the tissues without causing irritation are widely used as disinfectants and antiseptics. Chloramine-T is another chlorine antiseptic used in 3 to 5 per cent. solution in surgical practice. Internally chlorine mixture is widely used as an antiseptic in typhoid fever and in septicæmia. It is also used as a gargle, for syringing and rinsing fauces and nose in septic conditions.

BROMUM

(Bromine)

Bromine is a dark brown volatile liquid with a penetrating smell. It is not used in medicine as such.

1. **Acidum Hydrobromicum Dilutum.**—Dilute Hydrobromic Acid. A colourless, odourless liquid containing 10 per cent. of hydrogen bromide.

Dose—15 to 60 ms.—1 to 4 mils.

2. **Potassii Bromidum.**—Potassium Bromide occurs in colourless cubical crystals, readily soluble in water and with a saline taste.

Dose—5 to 30 grs.—0·3 to 2 G.

3. **Sodii Bromidum.**—Sodium Bromide, character and doses as above.

ACTION OF BROMIDES

External.—Bromine is a powerful caustic and an irritant externally, but the salts of bromine have no such action.

Internal.—*Alimentary Tract.*—Bromides in solution when painted on the mucous membrane of the throat, diminish its sensibility. In the stomach and bowels, bromides act as neutral salts but, given in large doses, they irritate the mucous membrane and produce nausea, vomiting and gastralgia by the hypertonic salt action.

Absorption and Elimination.—Bromides are absorbed from the stomach and intestines as sodium bromide. They displace the chlorides in the body in proportion to the amount of Bromine salts ingested. Their excretion is mainly in the urine, but as it continues over a long period, the salts accumulate in the body, if repeatedly administered. Small quantities are also excreted by the skin, saliva, sweat, bronchial and intestinal mucous membranes and milk. After absorption they exert their specific action on the nervous system.

Circulatory and Respiratory Systems.—These are not affected in an appreciable degree. Large doses, by their sedative action, may indirectly slow the heart, lower the blood pressure, and depress the respiratory centre.

Nervous System.—The chief action of the bromides is on the nervous system. Bromine ions act as a **sedative** to the entire central nervous system and its different parts are equally and simultaneously affected. The depression is mainly of the paths of communication between the sensory and motor cells of the cord and between sensory paths and the cerebral cortex. The connection between the cerebral centres and motor cells of the cord remains intact. Bromides therefore diminish the excitability of the cortical motor cells of the brain, of the medulla and of the spinal cord. The block between the sensory tracts and cerebral cortex lessens the acuteness of perception excited by impressions from the sensory organs, depresses the mind, induces lethargy, diminishes reflex activity and ultimately leads on to drowsiness and sleep. They are therefore used as **hypnotics.** The block between the sensory and motor tracts lessens the reflex activity of the spinal cord, as well as of the cardiac and respiratory centres in the medulla. Peripheral nerves are also depressed and later on even the voluntary muscles are affected, so that convulsions cannot be induced even by poisoning with strychnine. Owing to the depression of psychic centres in the brain and diminished reflex activity of the spinal cord, sexual appetite and sexual vigour are also lost, and thus the Bromides act as **Anaphrodisiacs.**

Bromism.—Chronic poisoning by the long continued use of bromides produces a group of symptoms which are known as *bromism*. These symptoms are: acneform eruptions on the skin chiefly of the face, neck and back; mental dullness, muscular weakness, drowsiness, digestive disturbances, and extinction of sexual desire. There is a little conjunctivitis and increased secretion of the bronchi. These symptoms slowly disappear by discontinuing the administration of bromides and by giving common salt which hastens their elimination.

THERAPEUTIC USES

Bromides are generally used in disorders characterised by irritability of the brain and spinal cord. They are therefore given in epilepsy, infantile convulsions, whooping cough, tetanus, strychnine poisoning, hysteria, insomnia, etc. Given with quinine, they diminish the tendency to cinchonism. They are also useful in some varieties of functional diseases of the heart.

IODUM

(Iodine)

1. Iodum.—Iodine occurs in bluish black laminæ with a metallic lustre. It is almost insoluble in water and volatilizes in an ordinary temperature giving off violet vapour. It has a peculiar pungent odour.

Incompatibles.—Metallic salts, mineral acids, alkaloids, tannic acid, volatile oils and starch. With oil of turpentine and ammonia it forms explosive compounds.

1. Liquor Iodi Aquosus. *Synonym.*—Lugol's Solution, Liquor Iodi Compositus. It contains 5 per cent. of Iodine and 10 per cent. of Potassium Iodide. 15 minims contain ¾ grain of Iodine and about 2 grains of total Iodine, free and combined.

Dose—5 to 15 ms.—0·3 to 1 mil.

2. Liquor Iodi Fortis. *Synonym.*—Tinctura Iodi Fortis. Contains 10 per cent. of Iodine dissolved in alcohol (90 per cent.) with Potassium Iodide 6 per cent. as a solvent.

3. Liquor Iodi Mitis. *Synonym.*—Tinctura Iodi Mitis. Contains 2·5 per cent. of Iodine and 1·5 per cent. of Potassium Iodide. 30 minims contain about ¾ grain of Iodine.

Dose—5 to 30 ms.—0·3 to 2 mils.

4. **Liquor Iodi Simplex.**—It is a 9 per cent. solution of iodine in alcohol (95 per cent.). 15 ms. contain 1¼ grs. of Iodine.

Dose—3 to 15 ms—0·2 to 1 mil.

5. **Syrupus Ferri Iodidi** (see Iron, page 164.)

2. **Potassii Iodidum.**—Potassium Iodide. Colourless crystals or granular powder with a bitter saline taste. Very freely soluble in water.

Incompatibles.—Mineral acids, oxidising agents and many alkaloids.

Dose—5 to 30 grs.—0·3 to 2 G.

3. **Sodii Iodidum.**—Sodium Iodide. Colourless crystals or white granular powder with a saline taste; soluble in water.

Dose—5 to 30 grs.—0·3 to 2 G.

ACTION OF IODINE AND IODIDES

External.—Free Iodine acts like chlorine by displacing the hydrogen atom in the molecule of protein and water. It is thus a powerful **disinfectant** and an **antiseptic.** It kills the parasites infesting the skin and acts as an **antiparasitic.** When applied to healthy skin, iodine is an **irritant,** the intensity of its action depending on the strength of the solution and the length of time it remains in contact. It may thus act as a **rubefacient** and a **vesicant.** Owing to its stimulant effect on the skin, it is largely used as a counter-irritant. It stains the skin yellowish brown and is absorbed by it. Iodides have very little external action.

Internal.—The inhalation of iodine vapour irritates the respiratory passages. When taken by mouth iodine sometimes checks persistent vomiting. In large doses it irritates the gastro-intestinal tract and produces vomiting, diarrhœa and colic. The salts of the iodine are much less irritant to the alimentary tract.

Absorption and Elimination.—Iodine is absorbed through the skin, from the mucous membranes and raw surfaces.

From whatever source it is absorbed, it is converted in the stomach to sodium iodide and albuminate of iodine and the former circulates in the blood as such and is excreted principally through the urine. A little is retained in the thyroid gland and small quantities leave the body through the respiratory and other mucous membranes and in secretions of all kinds—saliva, tears, bile and milk.

Remote Effects.—During the excretion through the bronchial mucous membrane, iodides increase the secretion of the bronchial glands and render it less viscid so as to cause its easy expulsion. They thus act as **expectorants.** In large doses, they act as **diuretics,** partly by salt action and partly by their eliminative stimulation. As they escape through the skin, they produce eruptions on it. They lessen the secretion of milk and if continued long they lead to atrophy of breast and testicle. They diminish sexual power.

Iodism.—Some persons are extremely susceptible to iodides in any form. Even in small doses, they produce in them troublesome symptoms of irritation which may occur in various mucous membranes and in the skin. These are called iodism. The first signs of intolerance are manifested by the running of the nose and eyes, sneezing and puffiness of the eyelids, frontal headache, congestion and swelling of the mucous membranes of the pharynx and larynx, aching in tempro-mandibular joint, and finally inflammation of the bronchi with increased secretion and cough. In some cases there may appear eruptions on the skin in the form of papules or pustules. Occasionally, there may be vomiting and diarrhœa. Iodides also increase the formation of Thyroxine and this explains the occurrence of rapid pulse, palpitation, nervous symptoms and loss of weight during their use. Nothing definite is known about the causation of iodism, but the tolerance to the drug is readily induced by giving it in minute doses and gradually increasing it to larger ones. As a rule, iodides are borne by children in proportionately larger doses than by the adults while liability to iodism is increased by old age, debility and deranged kidneys. It is diminished by administering the drug with large quantities of bicarbonate soda.

Specific actions of Iodides.—Iodides have a specific action in the later stages of syphilis, which are characterised by formation of new ill-developed tissues in the various parts of the body. These are all absorbed by treatment with Iodides. The probable method of action here is that the iodine is set free and combines with the cells of these growths, thereby accelerating their breaking down, which helps the drug to reach the parasite of syphilis more easily. The destruction of diseased tissues by the iodides stimulates the reproduction of healthy structure. They are therefore said to be **alterative** in effect.

Iodides are generally used in aneurysm and atheromatous conditions. Their beneficial effects in these conditions were supposed to be due to the fact that iodides lower the blood pressure, but they have no such effect. It is suggested that the predisposing cause of the above conditions may be found in the failure of the thyroid gland secretion, and iodides by stimulating the activity of the thyroid lead to the absorption of atheromatous tissue. Iodides are said to diminish the viscosity of the blood and thus prove beneficial in arterial degeneration and aneurysm. Iodides are useful as eliminants in chronic lead and mercurial poisonings acting by their solvent action on albuminates of these metals.

THERAPEUTIC USES

Iodine in 2 or 3 per cent. solution, is applied to sterilize the skin before an operation. It is used as a counter-irritant in chronic inflammatory conditions such as pleuritic effusion, rheumatic joints and glandular swellings. It is injected to produce adhesions into cysts and hydrocele. In combination with creosote, ether or chloroform, it is inhaled as an antiseptic in pulmonary tuberculosis. Iodine with glycerine is used as a paint in septic conditions of the mouth and the throat. Internally it is given in minute doses to check the vomiting of pregnancy. Iodides are used in tertiary stages of syphilis to absorb gummatous swellings and periosteal nodes. They are used in cases of bronchitis when the secretion is scanty and viscid. It is always an ingredient of asthma-mixtures. It is used in cases of hypothyroidism. Recently iodides are used topically with an electric current by ionic method as a resolvent in chronic infiltrative, proliferative or adhesive inflammations, especially those in or about the joints.

1. **Iodophthaleinum.**—Iodophthalein. *Synonym.*—Sodium Tetraiodophenolphthalein. It is a blue crystalline powder soluble in 7 parts of water.

Dose—45 to 60 grs.—3 to 4 G. by mouth.

30 to 45 grs.—2 to 3 G. by intravenous injection.

The dose is regulated in proportion to ⅓ or ½ grain per pound of body weight.

2. **Oleum Iodisatum.**—Iodised oil. *Synonyms.*—Oleum Iodatum, Iodatol, Iodinol, Iodipin, Lipiodol, Neo-Hydriol, Oliolase. This is an iodine addition product of poppy seed oil with hydriodic acid. It is a pale yellow viscous oily liquid with slightly alliaceous odour and bland oily taste. It contains 39 to 41 per cent. of combined iodine.

3. **Iodoxylum.** *Synonyms.*—Uroselectan, Pyclectan. It is white powder, odourless, freely soluble in water.

Dose—150 to 225 grs.—10 to 15 G. by intravenous injection.

ACTIONS AND THERAPEUTIC USES

IODOPHTHALEIN, as it is excreted almost wholly in the bile, is used to determine the functional powers of hepatic cells or the patency and condition of the bile ducts and gall bladder. The solution of the salt is impervious to the X-rays, and it is therefore also used for radiographic study of the gall bladder and ducts.

IODISED OIL is introduced into bronchioles, urethra, uterine cavity and fallopian tubes and into sinuses, in order to render these opaque to X-rays diagnosis of disease and new growths.

IODOXYL is non-toxic because no iodine is liberated, but, in susceptible persons, is irritating both internally or externally. It is X-ray diagnostic of the renal pelvis ureters and bladder as it is opaque to X-rays.

IODOFORMUM

(Iodoform)

Iodoformum.—Iodoform occurs in small glistening lemon yellow crystals or yellow powder, almost insoluble in water having a peculiar penetrating odour, sparingly soluble in alcohol and fixed oils and readily so in ether.

Dose—½ to 3 grs.—0·03 to 0·2 G.

1. **Oculentum Iodoformi.**—Contains about 4 per cent. of Iodoform.

2. **Suppositoria Iodoformi.**—Each contains about ·25 G. (about 3 grs.) of Iodoform.

ACTION OF IODOFORM

External.—Iodoform has no action on the unbroken skin, but when dusted on wounds or ulcers, it is decomposed by putrifactive materials, fats and bacteria and iodine is set free. The nascent iodine, combining with the protein material, exerts its **antiseptic** action and on the delicate skin causes eruptions to appear at the site of application. It dries the wound secretions and is mildly **analgesic** and **hæmostatic.** It is a powerful **deodorant.** Bismuth nitrate[1], and Iodoform[2], in paraffin commonly called 'Bipp,' is a valuable antiseptic dressing.

Internal.—Nothing definite is known about the internal action of iodoform. It is absorbed as such but the greater part is decomposed into the bowels by the alkaline fluids into iodides and is so taken up. It is excreted in the urine as Iodine, iodides and iodates.

THERAPEUTIC USES

It is used, as a dusting powder, on ulcers to stimulate their healing. In the form of emulsion with glycerine, it is used as an injection in tubercular joints, cold abscesses and other serous cavities to produce adhesions by irritating them with the slow liberation of free iodine. Inhalations of iodoform, either with turpentine, eucalyptol or creosote, dissolved in ether or in chloroform have been tried for tuberculosis of lungs with uncertain effect.

GROUP VI

NON-METALLIC SOLID ELEMENT

SULPHUR

1. **Sulphur Sublimatum.**—Sublimed Sulphur. *Synonym.*—Flowers of Sulphur. A greenish yellow gritty powder insoluble in water, having a faint odour and taste.

Dose—15 to 60 grs.—1 to 4 G.

Unguentum Sulphuris.—Contains 10 per cent. of Sulphur

Sublimed sulphur is contained in Pulvis Glycyrrhizæ Compositus.

2. **Sulphur Præcipitatum.**—Precipitated sulphur. *Synonyms.*—Milk of sulphur; Lac Sulphuris. A pale yellow amorphous powder much finer than the sublimed sulphur. Insoluble in water.

Dose—15 to 60 grs.—1 to 4 G.

Confectio Sulphuris.—Contains sulphur and acid potassium tartrate in a base of glycerine, syrup, tragacanth and tincture of orange.

Dose—60 to 120 grs.—4 to 8 G.

3. Potassa Sulphurata.—Sulphurated Potash. *Synonyms.*—Liver of Sulphur, Hepar Sulphuris. It occurs in liver coloured to yellowish green pieces, and contains various potassium sulphides. It is obtained by heating together potassium carbonate and sublimed sulphur.

ACTION OF SULPHUR AND SULPHURATED POTASH

External.—Sulphur externally is inert, but when applied to the skin in the form of an ointment, it is converted by the cutaneous secretion into sodium sulphide, which in the presence of moisture gradually leads to the evolution of hydrogen sulphide. Both these compounds combining with protein molecule destroy the low forms of life, both animal and vegetable, which infest the skin. It thus acts as a **parasiticide.** It is particularly useful in killing the parasite of itch (Sarcoptes Hominis). These products irritate the skin so that prolonged contact of sulphur may cause eczema on delicate skin. On raw surfaces, sulphur is converted into Sulphurous and Sulphuric acids and is, therefore, a severe **irritant.**

Internal.—*Alimentary Tract.*—Sulphur remains unaltered in the stomach. In the intestines, a certain amount is converted by the alkaline contents into alkaline sulphides and sulphuretted hydrogen. The sulphides exert a mild irritant and antiseptic action, and the sulphuretted hydrogen stimulates peristalsis. Sulphur thus acts as a **laxative** producing semisolid stools accompanied by offensive flatus of sulphuretted hydrogen which makes sulphur an undesirable purgative.

Absorption and Elimination.—Sulphur is absorbed into the blood as sulphide and sulphuretted hydrogen and circulates as such, but the absorption being small, it does not ordinarily produce the poisonous effects of sulphuretted hydrogen. Most of the sulphur is either excreted unchanged or as sulphide with the faeces. It is partly excreted by the urine in the form of sulphates and partly by the skin, lungs and intestines as sulphuretted hydrogen.

Remote actions.—Sulphur during the process of elimination through the lungs, exerts a mild irritant action on the mucous membrane of the bronchi, and increases the vascularity and secretions. Thus sulphur acts as an **expectorant.** Similarly it increases the secretion of the skin and gives it an offensive odour. It thus acts as a **diaphoretic.** Recently 1 per cent. solution in olive oil in doses of 0·5 to 10 mils. is injected intramuscularly every week to induce pyrexia of the treatment of neuro-syphilis of general paralysis of the insane and of chronic rheumatoid arthritis with considerable success.

Toxic actions.—Sulphur when absorbed in a large quantity as hydrogen sulphide, reduces and decomposes hæmoglobin with the formation of sulph-hæmoglobin. It produces symptoms of asphyxia and paralysis of nervous and muscular systems.

THERAPEUTIC USES

Sulphur is used externally in the treatment of skin diseases like scabies and acne. It is also used in the form of poultice in chronic rheumatic joints. It is given internally in the form of Confectio Sulphuris or Pulvis Glycyrrhizæ Compositus as a mild laxative to children and patients suffering from piles and other diseases of the rectum. It is also given in skin diseases, chronic bronchitis, chronic rheumatism and lead poisoning. Potassii Sulphurata is used in the form of ointment for the cure of scabies. Calcium sulphide is given in boils, carbuncles, etc.

GROUP VII

ACIDS

In this group only those acids will be considered which owe their action to the hydrogen ion contained in them. In the case of other acids such as hydrocyanic, benzoic and salicylic, the action of their negative ion is more powerful than the hydrogen ion. Such acids are treated along with their salts.

The acids acting by their hydrogen ion can be divided into two classes, inorganic and organic.

Inorganic Acids.—Acids Sulphuric, Nitric, Hydrochloric and Phosphoric.

Organic Acids.—Acid Tartaric, Citric, Lactic and Trichloracetic.

Boric Acid, though inorganic, is very feebly acid, but it possesses antiseptic properties.

INORGANIC ACIDS

1. **Acidum Sulphuricum.**—Sulphuric acid, a heavy oily liquid containing 95 per cent. of hydrogen sulphate. It is very hygroscopic and mixes with water with great evolution of heat.

Incompatibles.—Alkalies and their carbonates, lead and calcium salts.

Acidum Sulphuricum Dilutum.—Contains 10 per cent. of Hydrogen Sulphate.

Dose—5 to 60 ms.—0·3 to 4 mils.

2. **Acidum Nitricum.**—Nitric Acid, a colourless fuming liquid ; it contains about 70 per cent. of hydrogen nitrate.

3. **Acidum Hydrochloricum.**—Hydrochloric Acid. A colourless fuming liquid. It contains about 32 per cent. of hydrogen chloride.

Incompatibles.—Alkalies and their carbonates ; lead and silver salts.

Acidum Hydrochloricum Dilutum.—Contains 10 per cent. of hydrochloric acid.

Dose—5 to 60 ms.—0·3 to 4 mils.

4. **Acidum Phosphoricum.**—Phosphoric Acid. *Synonym.*—Acidum Phosphoricum Concentratum. A colourless, odourless liquid of syrupy consistency miscible with water and alcohol. It contains 89 per cent. of hydrogen orthophosphate.

Incompatibles.—Calcium preparations and Sodium Carbonate.

4. Acidum Phosphoricum Dilutum.—Contains about 10 per cent. of hydrogen orthophosphate.

Dose—5 to 60 ms.—0·3 to 4 mils.

5. Acid Hypophosphorosum Dilutum.—Dilute Hypophosphorous Acid.

Dose—5 to 15 ms.—0·3 to 1 mil.

It is contained in Syrupus Ferri Iodidi.

ACTION OF INORGANIC ACIDS

External.—Strong acids applied to the skin act as **irritants and caustics.** They, by precipitating the proteins and by extracting water from the tissues, act as general protoplasmic poisons and are, therefore, **antiseptics.** The **caustic** action of inorganic acids is limited, since they are neutralized by the alkalinity of the tissues and their effects vary in intensity according to the number of hydrogen ions or with their solubility and degree of dissociation. Sulphuric acid, owing to its great affinity with water, penetrates more deeply than other acids and causes the worst burns. It, however, leaves the carbon of the skin untouched, as shown by the charred appearance of the burn. Nitric acid has a limited caustic action, as the proteids it precipitates are not redissolved by it. It stains the skin yellow owing to the formation of nitro-derivatives of tyrosine. Hydrochloric acid is the least powerful of the mineral acids. It is not immediately destructive to the skin, but if its application is continued the skin becomes white and swollen and the upper layers necrotic. Concentrated phosphoric acid acts like sulphuric acid, but does not char the skin.

Moderately strong solutions of mineral acids act as **astringents** and **hæmostatics** by coagulating and contracting the albumen in the tissues and so constricting the blood vessels. In dilute solutions, they are cooling to the skin in fevers and act as **refrigerants.**

Internal.—*Alimentary Tract.*—All dilute acids have a sour astringent taste in the mouth and produce reflexly a slight increase in the secretion of the saliva, and thus allay thirst. In the stomach, they act as antiseptics and if the natural acid of the stomach is deficient, aid in peptic digestion, if given shortly after meal; hydrochloric acid being the best for this purpose. In the duodenum, acids reaching from the stomach stimulate the secretion of secretin, which, being absorbed into the blood, excites the secretion of the Pancreas. In this way acids may aid pancreatic digestion. They also stimulate the activity of the liver. In the intestines, acids are quickly converted into salts. Some of the acids, particularly dilute sulphuric acid, produce astringent action till they are neutralized.

Absorption and Elimination.—All acids are absorbed as neutral or acid salts from the alimentary tract. They are excreted in the urine as compounds of sodium, potassium and ammonium.

Blood.—Acids and acid salts, after absorption circulate in the blood and deplete the alkali reserve of the blood and make it acid. The increased acidity of the blood alters the metabolism and leads to the formation of more ammonia than urea from the nitrogen of the proteid. The ammonia is utilized to neutralize the acid and spare the alkali reserve of the blood. Some of the acids, particularly hydrochloric and nitrohydrochloric, are believed to increase the number of red blood corpuscles but not the amount of hæmoglobin.

Kidneys.—No free mineral acid is excreted by the kidneys. They form salts in the blood and act as mild **saline diuretics.** They render the urine acid by the formation of acid salts which irritate the kidneys and the bladder. By combining with ammonia they lower the excretion of urea. **Nitric acid,** after its absorption into the blood, is converted into ammonia, and hence slightly increases the **alkalinity** of the urine.

Toxic Action.—All mineral acids in concentrated solutions are powerful gastro-intestinal irritants, producing excoriation, slough and severe burning pain extending from the mouth to the stomach. There is tenderness and pain in the epigastric region, and vomiting of coffee coloured matter, containing clots of blood. These symptoms are accompanied by symptoms of collapse : cold perspiration, feeble and rapid pulse, intense thirst and dyspnœa due to laryngeal swelling.

THERAPEUTIC USES

Dilute Sulphuric Acid is used as an astringent for bleeding surfaces. It is given internally to check diarrhœa, dysentery and cholera. It is used as an antidote in cases of lead poisoning. Hydrochloric acid is given in dyspepsia caused by deficiency of the hydrochloric acid of the gastric juice. It is freely given in pernicious anæmia where it is absent or deficient. Nitric Acid is used as a caustic for syphilitic sores or phagedenic ulcers and is also used to destroy small growths such as warts, moles and granulations. In combination with hydrochloric acid, it is given in hepatic disorders and for relieving congestion of bile. Phosphoric acid is given internally as a tonic, alterative and refrigerant and to acidify urine. Dilute Hypophosphorous acid is also used as a tonic, mostly in combination with strychnine, quinine and iron. In pharmacy, it is used as a reducing agent in analysis and as a preservative to prevent decomposition of iodides in solution when exposed to air or light.

ORGANIC ACIDS

1. **Acidum Aceticum.**—Acetic Acid. It is a colourless liquid having a strong characteristic odour and sharply acid taste. Contains 33 per cent. by weight of hydrogen acetate.

1. **Acidum Aceticum Dilutum.**—Contains about 6 per cent. of hydrogen acetate.

Dose—30 to 60 ms.—2 to 4 mils.

2. **Oxymel.**—Contains acetic acid, water and honey, in proportion of 1,1,5, respectively.

Dose—30 to 120 ms.—2 to 8 mils.

2. Acidum Aceticum Glaciale.—Glacial Acetic Acid. It is a colourless, very acid liquid. Contains 99 per cent. of hydrogen acetate.

3. Acidum Citricum.—Citric Acid. It occurs in colourless crystals or white powder, freely soluble in water and has an acid taste. It contains 99·5 per cent. of hydrogen citrate.

Incompatibles.—Alkaline carbonates, acetates and potassium tartrate.

Dose—5 to 30 grs.—0·3 to 2 G.

4. Acidum Tartaricum.—Tartaric Acid. It occurs in large white crystals or white powder, freely soluble in water, and with an acid taste.

Incompatibles.—Salts of potassium, calcium, mercury, lead, and vegetable astringents.

Dose—5 to 30 grs.—0·3 to 2 G.

Citric and tartaric acids are made into effervescing draughts with alkaline carbonates. Their neutralizing capacity is as follows :—

> 35 grs. of Citric Acid neutralize 42 grs. of Bicarbonate of soda, 50 grs. of Bicarbonate of Potash and 26 grs. of Ammonium Carbonate.
>
> 35 grs. of Tartaric Acid neutralize 38 grs. of Bicarbonate of soda, 46 grs. of Bicarbonate of Potash and 24·5 grs. of Ammonium Carbonate.

5. Acidum Lacticum.—Lactic Acid, a colourless or slightly yellow, syrupy liquid, containing not less than 85 per cent. of hydrogen lactate.

Dose—5 to 20 ms.—0·3 to 1·2 mils.

> **Sodii Lactus.**—Sodium Lactate (70 per cent.). It is a pale yellow, viscous liquid. On cooling it forms a mass of moist crystals.

6. Acidum Trichloraceticum.—Trichloracetic Acid. It occurs in colourless deliquescent crystals, thaving characteristic pungent odour. It is very soluble in water, alcohol and ether.

ACTION OF ORGANIC ACIDS

External.—Acetic acid of the organic acids has the action resembling that of inorganic acids. In concentrated solution, it **irritates** the skin and causes congestion. In diluted solution, it is a **refrigerant** and a **local anhydrotic.** Glacial acetic, pure lactic and trichloracetic acids have the caustic properties of the concentrated inorganic acids, but even in strong solutions they are not destructive to the skin. Other acids of the group have no action on the unbroken skin, but on the raw skin, they cause irritation and pain. In concentrated solution they cause corrosion of the mucous surfaces.

Internal.—Like all acids, they stimulate the salivary secretion. In the stomach, free acids unite with the bases, to form new salts, and when given in effervescing form, they liberate carbonic acid gas, which acts as a gastric sedative. In the duodenum organic acids are converted into acetates, citrates and tartrates by the alkaline secretions. These salts will therefore raise the osmotic tension in the intestines to act as saline purgatives but they are given in too small a quantity to be effective that way. They are absorbed in the blood as salts of alkaline metals to increase the alkali reserve of the plasma ; their action, therefore, is identical with alkalies. They are excreted as carbonates, except in large doses when they escape partly unchanged. They act as **diuretics** and render the urine alkaline.

THERAPEUTIC USES

Strong Acetic Acid is used externally as a caustic and is used in the form of glacial acetic acid to destroy corns, warts, etc. In diluted solution, it is used as a cooling lotion in fever and to restrain excessive sweating. Citric and Tartaric acids in acidulous drinks are refreshing and useful to allay febrile thirst. They increase the quantity of urine and make it alkaline. In the effervescing form, they act as gastric sedatives and are useful to check vomiting. Lactic acid is given in intestinal toxæmia or it is taken in the form of butter-milk or milk artificially soured with lactic acid bacilli. Lactic acid in strong solution, as well as trichloracetic acid in crystals is used as an escharotic for warts, corns, mucous patches, etc. Sodium Lactate may be used as a substitute for glycerine in cataplasma Kaolini.

GROUP VIII

Water, Oxygen, and Carbon Dioxide

WATER

1. **Aqua Distillata.**—Distilled Water. It is a colourless, limpid liquid, tasteless and odourless. It is neutral in reaction and is prepared by distilling natural potable water.

2. **Aqua Sterilisata.**—It is prepared by distillation of potable water into a previously sterilised glass receiver. It is then transferred to a sterilised hard glass container and sterilised by heating in an autoclave for thirty minutes. The water so prepared is used within 24 hours after its preparation.

ACTION AND THERAPEUTIC USES OF WATER

External.—As the water could be raised or lowered to any required temperature, it is used to apply heat or cold to the surface of the body in the form of baths, which may be cold, indifferent, or warm, or hot.

Cold Baths have a temperature from 32° to 70° F. These baths increase the production of heat and abstract heat from the body by cooling the blood in cutaneous blood vessels. They therefore act as **refrigerants** in fevers. Cold baths cause constriction of superficial blood vessels and stimulate reflexly heart and respiration. The rate of the pulse and respiration rises for a time but soon falls to normal. Temporary overfilling of the internal vessels causes rise in the blood pressure. Immediately after the bath, there is a feeling of warmth, the cutaneous blood vessels dilate and diaphoresis occurs. Cold baths by inducing a soothing influence on the central nervous system **produce sleep.** In the form of ice or cold water, it is applied to isolated parts to reduce inflammation and stop oozing of blood from raw surfaces. It thus acts as an **antiphlogistic** and **hæmostatic.** It also acts as a counter-irritant by reflexly constricting the blood vessels of the parts underneath. It is for this reason that ice poultices are used externally on the skin of the chest in cases of Pneumonia.

Warm Baths have a temperature from 88° to 98° F. They have more cleansing properties than cold baths, relieve muscular spasms, dilate blood vessels, stimulate the secretion of sweat glands and act as **diaphoretics.**

Hot Baths have a temperature from 98° to 106° F. They are generally used locally in the form of fomentations and have the same effect as warm baths. They attract blood to the part to which they are applied drawing blood even from distant parts. They are therefore used to stimulate menstrual flow and to relieve internal congestion.

Internal.—*Alimentary Tract.*—Cold water relieves thirst, and when taken in moderate doses, at a proper time, it improves digestion by stimulating the gastric juice. It aids the passage of peptones into the blood. It is quickly incorporated with the circulating plasma by absorption. It renders the blood hydræmic and lowers its osmotic tension. The surplus water is quickly absorbed by the tissues and once more blood regains its normal osmotic balance. The mechanism of maintaining a constant balance of salts and water in the plasma is controlled by the post pituitary hormone through a water regulating centre in the hypothalamus. When there is excess of water in the tissues, it is got rid of by stimulating the kidneys and sweat glands to increase in their secretions and if it is deficient the pituitary hormone inhibits the action of the centre and causes the tissues to retain water to themselves. Given by the intravenous method water, being not isotonic with the blood, will pass into the red blood corpuscles and cause them to swell and disintegrate with the discharge of hæmoglobin into the plasma. **Hot water** is a gastric **sedative,** while **warm water** taken in large quantity acts as an **emetic.**

Absorption and Elimination.—Water is absorbed more rapidly from the small intestines, less from the large and hardly from the stomach. It is excreted by the kidneys, lungs and bowels. Water absorbed lowers the osmotic pressure of the blood.

Remote effects.—The lowering of the osmotic pressure causes increased filtration through the glcmeruli of kidneys with increased secretion of watery urine, which restores the normal osmotic pressure of the blood. It thus acts as a **diuretic,** cleanses the urinary tract and dissolves renal calculi. If from any cause, there is undue loss of water from the system, as in profuse sweating, the blood becomes concentrated, with an increase in its osmotic pressure. This diminishes the secretion of mouth and throat causing the sensation of thirst. The intake of water to allay thirst restores the blood to its normal concentration. In fevers, cold water acts as an **antipyretic** by facilitating perspiration and loss of heat.

OXYGEN

Oxygenium.—It is a colourless, odourless and tasteless gas and contains not less than 98 per cent. of oxygen by volume. One volume dissolves in about 43 volumes of water and in 3·6 volumes of alcohol (95 per cent.). It is inhaled as long as indicated by symptoms.

ACTION AND THERAPEUTIC USES

Oxygen inhalations are given therapeutically in asphyxial conditions where the access of oxygen to the blood is hindered. This occurs when there is mechanical obstruction to the respiratory passages in cases of suffocation, when the air surcharged with poisonous vapours is inhaled as in chloroform or carbon monoxide poisoning, in diseases of the respiratory or circulatory systems, which markedly lessen the supply of oxygen to the tissues, and in deficiency of hæmoglobin in the blood as in cases of anæmia or after-hæmorrhage.

For use, compressed oxygen is supplied in metal cylinders to which a soft rubber tube is easily attached from which the gas is allowed to pass through a wash bottle, containing brandy and water or warm water, before it is inhaled from a tube passed into the nostrils or mouth, or through a well fitting anæsthetic mask. The moistened gas does not irritate the respiratory mucous membrane. Its administration should be continuous and sufficiently rapid so as to produce a positive oxygen pressure in the alveoli of the lungs.

CARBON DIOXIDE

Carbonei Dioxidum. *Synonyms.*—Carbonic acid; Carbonic acid gas. It is a heavy colourless gas with a faintly acid taste in an aqueous solution. For convenience in use it may be compressed in metal cylinders.

ACTION AND THERAPEUTIC USES

External.—Carbon dioxide in the form of effervescing baths act as a **stimulant to the skin**; they dilate cutaneous vessels, lower blood pressure and, reflexly, stimulate the heart.

Carbon dioxide, when allowed to escape from the cylinders into a suitable receptacle, condenses and forms a semi-solid snow, which can be moulded into a stick for application to parts which require mild **penetrating caustic** action for cure, as in the case of nævi, port-wine stains, lupus, rodent ulcers, etc. Thus in its solidified form it acts as an escharotic.

Internal.—Carbon dioxide, in effervescing drinks, stimulates gastric mucous membrane, therefore, **acts stomachics,** and increases the rate of intestinal absorption, especially of water, therefore, relieves thirst, and promotes diuresis.

Inhalation of carbon dioxide in 3 to 10 per cent. admixture with oxygen is used to **stimulate the respiratory centre by direct action.** It is administered successfully to arouse respiration in the new-born, in drowning, in alcoholism, to hasten the expulsion of alcohol by the lungs, in Cheyne-Stokes respiration, cardiac conditions with cyanosis, hiccough, and in poisoning by Morphine, general anæsthetics, organic hypnotics and Carbon monoxide.

PART IV

ORGANIC MATERIA MEDICA

It includes drugs from the vegetable and animal kingdoms and the synthetic preparations.

The drugs in this section are arranged according to the similarity of their action.

GROUP I

DRUGS ACTING ON THE CENTRAL NERVOUS SYSTEM

These drugs are classified according to the portion of the Nervous System on which they prominently act to produce either a stimulant or depressant effect.

Class I.—Drugs acting on the Cerebrum.

A. Cerebral Depressants
   - (*a*) Anodyne Narcotics—Opium.
   - (*b*) Hypnotics—Chloral Hydrate and others.

B. Cerebral Depressants with a loss consciousness and reflex activity.
   - (*a*) General anæsthetics—Chloroform and others.

C. Cerebral Exhilarants or Delirients.—Caffeine, and the Belladonna group but the latter has its prominent action on the peripheral (autonomic) nervous system.

Class II.—Drugs acting on the Spinal Cord.

A. Spinal Convulsants.—Nux-Vomica, Nikethamide, Leptazoli.

B. Spinal Depressants.—Physostigmine, but its chief action is on the peripheral (autonomic) nervous system.

Class III.—Drugs acting on the Nerves.

A. Depressing the motor nerve-endings of the voluntary muscles.—Conium, Curare, Tobacco. None of these are official.

B. Depressing the sensory nerve-endings. Cocaine, and its substitutes and Aconite.

C. Stimulating the sensory nerve-endings. Skin-irritants, and Counter-irritants. Such as cantharidin and volatile oils which are described under a separate group.

Class I

DRUGS ACTING CHIEFLY ON THE CEREBRUM
A. CEREBRAL DEPRESSANTS

OPIUM

Opium is obtained by incising the unripe capsules of *Papaver Somniferum* (white poppy) which is grown in Asia Minor, India and China. The fresh juice as it flows forth is milk-white, which later on, *in situ*, stiffens into reddish-brown tears. It is then scraped off, dried by spontaneous evaporation and kneaded into a mass which assumes a blackish-brown colour by being kept. It has a characteristic odour and a bitter taste. Commercially the shape of the mass distinguishes the country of its export. Asia Minor opium occurs in small, round, flattened cakes wrapped in leaves ; Persian opium in bricks or cones wrapped in red paper ; Indian opium in balls in poppy leaves. **Opium contains in its moist condition, not less than 9·5 per cent. of morphine, calculated as anhydrous morphine.**

Composition.—Opium is an exceedingly complex substance containing about 18 to 20 alkaloids mostly in combination with *meconic* or *thebolactic acid*, a neutral body *meconin* and the remainder made up of mucilage, albumen, resin, gums, essential oils, wax, sugars, colouring matters, water and the inorganic salts of ammonium, calcium and magnesium. The important alkaloids of opium are *morphine*, *codeine*, *thebaine*, *narcoline, narceine, papaverine.* Of these the quantity of morphine is the largest, 1/10 gr. of morphine is equal to 1 gr. of opium.

Incompatibles.—Alkalies, soluble salts of heavy metals, tannin. Oxidising agents destroy morphine.

1. Opium Pulveratum.—Opium dried at a moderate temperature and reduced to a fine powder. Standardised to contain 10% of morphine.

Dose—$\frac{1}{2}$ to 3 grs.—0·03 to 0·2 G.

2. Extractum Opii Siccum.—Dry extract of opium. Standardised to contain 20 per cent. of morphine. 1 grain contains $\frac{1}{5}$ gr. of morphine.

Dose—$\frac{1}{4}$ to 1 gr.—0·015 to 0·06 G.

3. Pulvis Cretæ Aromaticus cum Opio.—Aromatic powder of chalk with opium. Contains 2·5% of powdered opium equivalent to 0·25 per cent. of morphine. 60 grs. contain $\frac{1}{7}$ gr. of morphine.

Dose—10 to 60 grs.—0·06 to 0·4 G.

4. Pulvis Ipecacuanhæ et Opii. *Synonyms.*—Pulvis Ipecacuanhæ Compositus; Dover's Powder. Powder of Ipecacuanha and opium diluted with lactose. Contains 10 per cent. of powdered opium equivalent to 1% of morphine. 10 grains contain 1 gr. of morphine.

Dose—5 to 10 grs.—0·3 to 0·6 G.

5. Suppositorium Plumbi cum Opio. *Synonym.*—Suppositorium Plumbi Compositum. Each suppository contains 3 grs. of lead acetate and 1 gr. of powdered opium.

6. Tinctura Opii. *Synonym.*—Laudanum. Standardised to contain 1% of Morphine. 30 minims contain about $\frac{1}{3}$ gr. of morphine.

Dose—5 to 30 ms.—0·3 to 2 mils.

7. Tinctura Opii Camphorata. *Synonyms.*—Tinctura Camphoræ Composita; Tinctura Opii Benzoica; Paregoric. It consists of Opium, Benzoic acid, Camphor and Oil of Anisi. It is standardised to contain 0·5% of morphine. 60 minims contain 1 grain of morphine.

Dose—30 to 60 ms.—2 to 4 mils.

8. Tinctura Opii Camphorata Concentrata.—It has approximately eight times the strength of Camphorated Tincture of Opium, in 8 minims about 1/30 grain of morphine.

Dose—4 to 8 ms.—0·25 to 0·5 mils.

Morphinæ Hydrochloridum.—Morphine Hydrochloride occurs in acicular crystals with a bitter taste, and is soluble in 25 parts of water.

Incompatibles.—Salts of heavy metals, alkaline earths, tannins, liquor arsenicalis.

Dose—$\frac{1}{8}$ to $\frac{1}{3}$ gr.—0·008 to 0·02 G.

1. **Liquor Morphinæ Hydrochloridi.**—Contains 1 per cent. of morphine hydrochloride. 30 minims contain $\frac{1}{4}$ gr. of morphine hydrochloride.

Dose - 5 to 30 ms.—0·3 to 2 mils.

2. **Suppositorium Morphinæ.**—Each contains $\frac{1}{4}$ gr. of morphine hydrochloride.

3. **Trochiscus Morphinæ et Ipecacuanhæ.**—Contains $\frac{1}{10}$ gr. of Ipecacuanha powder and $\frac{1}{3}$ gr. of morphine hydrochloride.

Morphinæ Sulphas.—Morphine sulphate occurs in acicular crystals, with a bitter taste, and is soluble in 16 parts of water.

Dose—$\frac{1}{8}$ to $\frac{1}{3}$ gr.—0·008 to 0·02 G.

Morphinæ Tartras.—Morphine Tartrate. White acicular crystals soluble in 11 parts of water.

Dose—$\frac{1}{8}$ to $\frac{1}{3}$ gr.—0·008 to 0·02 G.

ACTION OF OPIUM AND MORPHINE

The action of opium is mainly due to its chief alkaloid morphine, and as such, all that is said about opium apply to morphine.

External.—Opium, owing to the difficulty of its absorption, has no action **on the unbroken skin.** It is, however, used in the form of spirituous solution to act as a local anodyne. It is absorbed from raw and mucous surfaces and relieves the pain of wounds and ulcers.

Internal.—*Alimentary Tract.*—Opium, owing to various alkaloids found in its composition having different or contrary actions, exerts two distinct types of actions on the digestive system. **One set of actions is dependent on its absorption into the circulation, and the other is due to its excretion into the stomach and intestines.** Opium in small doses has very little action on the stomach. Given in moderately large doses, opium, by its central action after absorption, stimulates the vomiting centre to induce nausea which, as usual, is accompanied by salivation. In the absence of nausea, the mouth becomes dry and the patient becomes thirsty from the depression of the salivary centre with the consequent diminished secretion of the saliva. The sensation of hunger is diminished, appetite is lessened, and the gastric pain is relieved. Its excretion into the stomach depresses the peripheral nervous mechanism there and causes **diminished secretion of the gastric juice** with consequent **impairment of digestion. Prolonged contracture of the pyloric sphincter and the relaxation of the fundus of the stomach** are produced causing delay in the emptying of the stomach contents.

In the intestines, owing to the diminished secretion by central action and sufficient quantity of the material being not thrown into the small intestines from the stomach, opium **retards peristaltic movement** and this effect is further heightened by the lessened sensitiveness of the bowels to the normal stimuli. The excretion of opium into the intestine stimulates the peripheral nervous mechanism which excites spasm of the ileo-cœcal valve, causing thereby a great delay in the forward movement of its content and allowing more time for its dehydration. The sensitiveness and movements of the large bowels are also diminished and the defæcation reflex is delayed. The combined effect of these actions results in **constipation** and hard stools. The retardation of the peristaltic movement gives a physiological rest to the intestines, which is helpful in checking intestinal hæmorrhage. Opium, therefore, in therapeutic doses acts as a gastric and intestinal sedative.

Absorption and Elimination.—Opium is rapidly absorbed from all mucous surfaces, but scarcely from the unbroken skin. It quickly disappears from the blood and is partly destroyed in the tissues and partly stored up in the organs, particularly in the liver. It is excreted mainly by the gastro-intestinal tract and is again re-absorbed into the system; hence the necessity of emptying the stomach in cases of poisoning by morphine, even after subcutaneous administration. A small quantity is also excreted in the milk, saliva, sweat and urine.

Nervous System.—After absorption, the chief action of opium is on the central nervous system; its effects on the other systems are, in the main, indirect being through its influence on the nervous mechanism controlling them. It has a general depressant action, and in that follows the two laws regarding the drugs acting on the central nervous system, the "Law of Initial Stimulation and then Depression" and the "Law of Dissolution." The initial stimulation by opium, according to some, is more an effect of its primary depressing action on the sensory pathways to the cerebral cortex above the reflex arc. Opium or morphine in small doses, after a brief period of stimulation, depresses the various cerebral centres, in the reverse order of their development. The psychical centres which are developed late in life are first stimulated and then depressed. The imagination is powerfully and pleasantly excited with a sense of happiness and comfort. There is often a temporary increase of mental and bodily vigour followed by dullness and apathy to work. Reason and judgment are impaired and extravagant ideas are indulged in. Later on, the patient likes to be undisturbed in a condition of mental apathy and languid ease—the commencing signs of direct depression of the functional activities of the cerebral cells. The sensory stimuli do not affect the perceptive centres in the brain but the **sensibility to pain is abolished.** The patient is now overcome by drowsiness and passes on to sleep, which is, sometimes, accompained by dreams of a fantastic nature. The patient, however, could be roused from his sleep by sharp stimulation and induced to walk, if supported, without any signs of muscular weakness; but if left to himself, he soon lapses into sleep. In doses, larger than the therapeutic ones, the stage of stimulation is absent. Drowsiness and deep sleep follow immediately. The sensory areas in the brain are profoundly depressed, **pupils** are **contracted** to pin points by the stimulation of the pupillary centre at the base of the brain. The accommodation is disturbed and there is a rise of intra-ocular pressure. Just before death, pupils are, however, dilated and this is probably due to the increased venosity of the blood caused by the failing respiration.

In small doses, the motor cells of the **spinal cord** are stimulated showing excessive reflex activity; with larger doses they are **depressed** and the reflex movements are elicited with great difficulty.

The medullary centres are not uniformly affected by opium or morphine. The vomiting centre is stimulated; the cardiac centre is unaffected, if at all, it is stimulated and the **vaso-motor** and **respiratory centres** are **depressed,** the latter more profoundly.

The motor and sensory nerves remain unaffected by opium unless administered in very large doses, in which case the sensory nerves are depressed before the motor ones. The irritability of the muscles remains up to the last.

Circulatory System.—The therapeutic doses of opium have very little effect on the circulation. In moderately large doses, there is acceleration of the heart if nausea is present; but it is soon slowed down, owing to the stimulation of the vagal centre. The incipient depression of the vasomotor centre causes the dilatation of the blood vessels of the skin without affecting the blood vessels of the splanchnic area. The blood pressure, therefore, remains unaffected. In poisonous doses the vagal centre as well as vagal endings in the heart, are **irritated,** causing considerable slowing of the heart, which is further retarded by the asphyxial

Conditions modifying the action of Opium and Morphine.

Idiosyncrasy.—The effects of Opium differ with the varieties of people to whom it is administered. This is probably due to the varying compositions of opium. With some, the stage of excitement is a prolonged one. They suffer from delirium and insomnia. In such cases, if the therapeutic indications necessitate its use, it should be combined with chloral hydras or bromides, which increase its soporific action. Some suffer from gastric irritation ; while in some, the skin troubles, such as urticaria and itching, are more marked. Injection of morphine produces occasionally a brisk purge as in some animals. This is due to the paralysis of the splanchnic ganglia, which removes their inhibition effect on the intestinal movements. Suspension of breathing, asphyxial convulsions, as well as partial heart block, are also seen, though rarely.

Age.—Susceptibility to opium is greatly increased at both extremes of life—childhood and old age. With children, it may be accounted for by the disproportionately large size of their brain. In these extremes of life, the dose must be much smaller than the one proportionate to their ages.

Sex.—Women do not tolerate opium well. They are more sensitive to its exciting influence than men, and it sometimes aggravates their restlessness instead of calming it.

Habit and Tolerance.—A continued administration of the drug to produce a specific effect such as relief of pain, produces habit and tolerance. The dose has, therefore, required to be increased to produce the original effect. This tolerance of opium and morphine may be due to increase in the powers of the organism to destroy morphine, but since the destruction proceeds more slowly than the absorption, the tolerance acquired may also be due to the increased rate of excretion, or to cellular immunity, the cells becoming less affected by the same amounts.

Disease.—Persons suffering from painful affections bear opium well and tolerate a larger dose of it. Alcoholic persons suffering from cardiac, pulmonary and renal diseases, and persons with cerebral congestion do not bear opium well, and to them it should be given with caution. On the other hand persons suffering from diabetes, delirium tremens and tetanus tolerate large doses of opium.

Opium v/s. Morphine.—Though the action of opium is mainly dependent on its most important alkaloid, yet there are some differences of action between them, and these are dependent on their solubility. (1) Opium is less soluble than morphine; (2) it is more slowly absorbed; (3) its effects are more lasting; (4) its action on the intestines is more pronounced, as it reaches the bowels directly, and it is more constipating; (5) opium, with all its alkaloids, is a better relaxant of the smooth muscles and produces some degree of local analgesia. It is for this reason preferred in many cases of intestinal and abdominal troubles. (6) The narcotic effect of opium is less pronounced than morphine, as several of its other alkaloids, such as thebaine, codeine and narcotine, are more or less convulsants. (7) Opium stimulates the cerebral cortex, respirations and cardiac functions more powerfully than morphine. (8) It is a better diaphoretic than morphine. (9) Opium is more powerful in reducing the amount of sugar in the urine. Morphine causes more dryness of the mouth, interferes more with the kidney and bladder functions, and is more likely to produce itching. In spite of these disadvantages, morphine is preferably to opium where promptness of action and certainty of effect are desired, as in the relief of pain and to produce sleep. To achieve these ends it must be administered by the hypodermic method.

Antagonism.—A good many drugs can be cited as antagonistic to morphine; but caffeine is the only drug which is its most complete physiological antagonist. It stimulates the entire central nervous system including the cerebral cortex, respiratory, cardiac and vaso-motor centres and the spinal cord. Its predominant action consists in stimulating the psychical centres which are depressed by opium and morphine.

Other drugs exert antagonistic action in some part or other of the nervous system.

Atropine opposes the action of morphine on the autonomic nervous system. The pupils, which are contracted by the central action of morphine are dilated by atropine acting peripherally on the endings of the third nerve. The heart, which is slowed by stimulation of the vagus centre, is quickened by the paralysing effect of atropine on the vagal endings in the heart. The secretion of sweat which is increased by morphine acting centrally is checked by atropine paralysing the terminal ends of the nerves in the sweat glands. These apparent antagonistic effects are not useful in severe cases of poisoning by opium or morphine. The real antagonistic effect of atropine consists in the stimulation of the cerebral convolutions, respiratory centre, and intestinal peristalsis, which are all depressed by morphine. These effects are all to be found if atropine is used in moderate doses. In larger doses, atropine is a synergist to morphine as its later paralytic effects coincide with those of morphine, while the small stimulant doses of atropine prove to be too weak to awaken the centres which are powerfully depressed by poisonous doses of morphine.

Bromides oppose the action of morphine on the cord, strychnine on the heart and ammonia on the respiratory centre.

Synergism.—All anæsthetics, narcotics and sedatives assist the action of opium on the brain. Its anodyne action is much increased by antipyretics of the coal-tar group. Ipecacuanha aids its diaphoretic action. A combination of scopolamine and morphine increases each other's hypnotic action and the effect produced is greater than the sum of their action. A very marked synergism is seen between chloral hydras and opium. Both these drugs act as hypnotics, but they have many points of difference, which are as follows :—

Chloral v/s. Opium.—(1) Chloral hydrate is a quicker, a more certain and more refreshing hypnotic than opium. (2) There are no after-effects such as headache, depression, nausea and constipation, which are common with opium. (3) It cannot relieve pain and induce sleep when it is present. (4) It cannot relieve reflex cough like opium, but it can give relief in convulsive diseases, which is not obtainable by the administration of opium.

THERAPEUTIC USES

Opium and morphine are mainly used to relieve pain, to lessen restlessness and shock, to induce sleep, to check peristalsis, to prevent reflex cough, to relax muscular spasm, particularly of the gastro-intestinal tract, and to check secretion. These indications are found in a variety of diseases, and such cases increase the usefulness of opium ; but it must be used with discretion, for, the relief is generally symptomatic and may interfere with the natural process of repair or obscure the diagnosis and progress of the disease. Its subsidiary uses are to check intestinal hæmorrhage, to induce sweating, to check hypersecretion, especially of the bowels and kidneys, and to check the passing of sugar in urine in diabetes.

Codeina.—Codeine. *Synonym.*—Methyl-morphine. An Alkaloid obtained from opium or prepared from morphine. It occurs as colourless trimetric crystals, soluble in 120 parts of cold water, easily soluble in boiling water and freely in alcohol or chloroform.

Dose—¼ to 1 gr.—0·016 to 0·06 G.

Codeinæ Phosphas.—Codeine phosphate. Contains not less than 67 per cent. of anhydrous codeine. It occurs in fine needle-shaped crystals with a slightly bitter taste and is easily soluble in water.

Dose—¼ to 1 gr.—0·016 to 0·06 G.

ACTION AND THERAPEUTIC USES OF CODEINE

The action of codeine resembles that of morphine in some respects but it is much weaker. It is less hypnotic and analgesic, while it has a greater tendency to increase reflex irritability of the spinal cord. It lessens the cough-reflex without depressing the respiratory centre. It is therefore largely used to relieve the hacking cough of phthisis. It is less constipating and may even cause diarrhœa. Larger doses cautiously administered, are useful in relieving ovarian pain and in diminishing the amount of sugar in diabetes. It is not habit forming as the psychical centres are left unaffected.

Diamorphinæ Hydrochloridum.—Diamorphine Hydrochloride. *Synonym.*—Heroin Hydrochloride. It is an alkaloid obtained from morphine. Occurs as a white crystalline powder of bitter taste ; soluble in 3 parts of water.

Dose—$\frac{1}{24}$ to $\frac{1}{8}$ gr.—0·0025 to 0·008 G.

ACTION AND THERAPEUTIC USES OF HEROIN HYDROCHLORIDE

Like morphine, it exerts its chief actions on the respiratory and nervous systems. In therapeutic doses, it is less analgesic, less constipating, but more depressant to the respiratory centre, than morphine. It has therefore a great soothing influence on the irritating coughs of laryngitis, bronchitis and pulmonary tuberculosis. Like morphine, but unlike codeine, it tends to establish the habit to produce tolerance after continued use.

Apomorphinæ Hydrochloridum.—Apomorphine Hydrochloride. The hydrochloride of an alkaloid prepared from morphine by the abstraction of one molecule of water. It occurs in greyish-white glistening needles, acquiring a greenish tint upon exposure to light and air ; soluble in 50 parts of water and in alcohol. Faintly acid in reaction.

Dose—$\frac{1}{32}$ to $\frac{1}{8}$ gr.—0·002 to 0·008 G. Hypnotic and emetic by injection.
$\frac{1}{64}$ to $\frac{1}{32}$ gr.—0·001 to 0·002 G. expectorant by mouth.

ACTION AND THERAPEUTIC USES OF APOMORPHINE

Notwithstanding its relationship with morphine, apomorphine exerts a very different action on the central nervous system. In moderate doses, it does not produce analgesic action, but **selects only the vomiting centre** in the medulla for its action and acts as a prompt **emetic.** That it is a central emetic is demonstrable by the fact that even small doses of the drug given hypodermically act more promptly than what is given by the mouth, and by the fact that the vomiting occurs also after the section of both the vagi which abolishes the effect of those emetics which act only peripherally, *i.e.*, on the gastric mucous membrane. In doses too small to cause vomiting or even nausea, it increases the secretion of saliva and bronchi and acts as a stimulant **expectorant.** In emetic doses, apomorphine has no effect on the circulatory system, except the fall of blood pressure with the slowing of the heart, which always accompanies emesis and is dependent on stimulation of the vagus nerve. There may also be preliminary acceleration of the heart due to the direct stimulation of the accelerator centre.

Therapeutically, apomorphine is used as a prompt emetic in cases of poisoning. It acts with great certainty and could be administered hypodermically to patients who are unconscious or who refuse to take medicine. It produces emesis within about 10 minutes after comparatively slight prodromal symptoms and subsequent collapse.

By mouth, it is given to relieve the dry hacking and unproductive cough which sometimes persists after recovery from acute or subacute bronchitis. It is also useful as an expectorant to relieve the dry cough attendant at times upon various febrile affections.

HYPNOTICS

General Remarks.—**All aliphatic anæsthetics in smaller concentration will act as hypnotics, but the hypnotic stage is**

too brief owing to the quick absorption of the anæsthetics, and if pushed on to prolong this stage, it passes into general anæsthesia with its undesirable side actions of stimulation, irritation and depression. The idea of inducing sleep is to help the cells of the cerebral cortex to recover from fatigue and to regain their normal function. This could only be attained by prolonging the hypnotic stage without inducing any further fatigue in the cells of the cerebral cortex by initial stimulation as is done by the anæsthetics. A drug, therefore, to act as a hypnotic must get slowly absorbed from the bowels rather than by quick absorption and equally rapid elimination from the lungs. An ideal hypnotic, therefore, must have the following qualities :—

(1) It must be soluble in water for its absorption. (2) Its effect must be prompt and lasting. (3) It must not possess any odour or taste that will prevent its use. (4) It must not irritate the stomach, (5) nor produce cumulative action, (6) nor induce tolerance, (7) nor establish habit ; and (8) its elimination must be rapid so as to prevent after effects. (9) It must also not produce any primary stimulation of the cerebral cortex ; and (10) it must not depress the vital centres in the medulla in the production of the maximum hypnotic stage.

With these quantities in view a host of synthetic hypnotics are produced ; all of which have some flaw or other. They all, however, progressively, according to the dose, depress the areas of consciousness in the brain and then the sensory and motor areas. The spinal cord and the medullary centres are affected last. These hypnotics are divided into the following groups according to their chemical relationships.

(1) **Alcohol group.**—Amylene Hydrate, Tribromœthyl Alcohol, Bromethol.

(2) **Halogen group.**—The drugs belonging to this group are formed by the introduction of chlorine into the drugs of the aldehyde group, to increase their hypnotic power, *e.g.*, Chloral-hydrate, Chlorbutol.

(3) **Aldehyde group.**—The drugs belonging to this group are formed by introducing an alkyl radical—any univalent alcohol radical—into the Aldehydes which are formed from alcohol by oxidation, *e.g.*, Paraldehyde.

(4) **Sulphone group.**—The drugs belonging to this group are formed by the union of the alkyl radicals, either methyl or ethyl, with the disulphones. The ethyl radical is said to be more hypnotic in its action, *e.g.*, Sulphonal, Methyl Sulphonal.

(5) **Urea group.**—These hypnotics are formed by associating the alkyl radicals with the urea derivatives, *e g.*, Barbitone, Adaline, Luminal.

ALCOHOL GROUP

AMYLENE HYDRATE

Amyleni Hydras. *Synonyms.*—Tertiary Amyl Alcohol, Dimethyl-ethyl carbinol. It is a clear volatile liquid ; taste pungent and odour like camphor ; soluble in ten parts of water, freely in alcohol.

Dose—30 to 60 ms.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

Amylene Hydrate is a mild hypnotic, intermediate in action between chloral hydrate and paraldehyde. It causes gastric irritation and mental excitement. It is given in capsules.

TRIBROMŒTHYL ALCOHOL

Alcohol Tribromœthylic. *Synonyms.*—Tribromœthyl Alcohol, Avertin. A white crystalline powder, odour and taste slightly aromatic. It is soluble 1 in 35 parts of water at 30°C. At a slightly higher temperature its solutions liberate the irritating hydrobromic acid, and at a lower temperature may precipitate crystals ; is readily soluble in light petroleum and in amylene hydrate.

Dose—½ to ¾ gr. per pound of body weight.
0·075 to 0·1 G. per kilogram of body weight.

By rectal injection as a basal anæsthetic.

Bromethol. *Synonym.*--Solution of Tribromœthyl Alcohol. Dissolves the Tribromœthyl in the Amytene Hydrate in proportion 2 to 1.

Dose—Same as Tribromœthyl Alcohol.

ACTION AND THERAPEUTIC USES

Avertin is depressing to the cerebrum and to the respiratory and vaso-constrictor centres. It is rapidly combined in the liver with glycuronic acid and eliminated in the urine. The requisite dose in an aqueous solution, if slowly injected high in the rectum, brings about narcotic sleep in three to ten minutes and is followed by anæsthesia lasting for a hour or two. There are little or no after effects, but it is contra-indicated in inflammatory conditions of rectum and colon; diseases of liver and kidneys and severe malnutrition.

HALOGEN GROUP.

CHLORAL HYDRAS

Chloralis Hydras,—Chloral Hydrate. It occurs in colourless crystals, having an aromatic, penetrating odour and a sharp caustic taste. Very readily soluble in water and in olive oil.

Dose—5 to 20 grs.—0·3 to 1·2 G.

Incompatibles.—All alkalies decompose it liberating chloroform.

ACTION OF CHLORAL HYDRATE

External.—The Chloral hydrate in weak solution is an **antiseptic.** In concentrated solution, when rubbed on the skin, it is an **irritant** giving rise to a rubefacient effect. On mucous surfaces, the irritant effect is more marked. In combination with camphor and menthol, it acts as a **local anodyne.**

Internal.—*Alimentary Tract.*—In concentrated solution, it irritates the mucous membrane of the stomach, and unless well diluted may cause gastric pain and vomiting. Its use, if continued long, may even cause diarrhœa.

Absorption, Transformation and Elimination.—Chloral hydrate is quickly absorbed from the mucous membrane of the stomach and intestines. It enters the blood unchanged and exerts no action there. It is carried to the tissues and is converted into trichlorethyl (an alcohol which acts like chloral hydrate) which combines with glycuronic acid (a decomposition product of carbohydrate metabolism) and forms urochloralic acid. Urochloralic acid with some unchanged chloral hydrate is then excreted by the kidneys. Urine containing urochloralic acid reduces Fehling's Solution. This fact led to the erroneous belief that chloral hydrate causes glycosuria. Chloral, to some extent, is also excreted by the skin as eruptions appear after its prolonged use.

Circulatory System.—Chloral hydrate in therapeutic doses has hardly any action on the heart; but in large doses it, like chloroform, acts on the muscle of the heart and diminishes the rate and force of its contractions. In poisonous doses, the heart stops in diastole. The vaso-motor centre is paralysed, consequently blood vessels dilate and, as a result of this combined action the blood pressure falls.

Respiratory System.—In large doses alone, it **depresses the respiratory centre** and renders the breathing slow and shallow. In poisonous doses the respiratory centre is paralysed and death ensues by respiratory failure.

Metabolism.—Chloral hydrate affects metabolism in the same way as chloroform. It lowers the respiratory exchange. The absorption of oxygen and the excretion of carbon dioxide gas is diminished; in larger doses or in continuous administrations, it causes the breakdown of tissue proteins as seen by the increase of nitrogen and sulphur in urine and ultimately leads on to the fatty degeneration of the tissues. Urine reduces Fehling's Solution.

Temperature.—Large doses of chloral hydrate produce a fall in temperature. This is a combined effect of the cutaneous dilatation of blood vessels, diminished production of muscular movement, and the depression of the heat-producing centre in the brain.

Nervous System.—Chloral hydrate depresses the central nervous system in the same order as the general anæsthetics, that is, first the brain, then the spinal cord, and lastly the medullary centres. In therapeutic doses, however, it depresses only the areas of consciousness in the brain and hence its value as a hypnotic. Soon after its administration the patient feels drowsy, falls into sleep, closely resembling natural sleep, which lasts for 6 to 8 hours. The sleep is not followed by any after-effects such as headache, vomiting and drowsiness. The sensory areas in the brain are not depressed nor the spinal reflexes abolished. The pain therefore is not abolished and the patient can be roused from the sleep as from a natural one. In larger doses, the sleep induced is deep and prolonged, from which it is difficult to rouse the patient. The sensory areas are dulled and the spinal reflexes are diminished, owing to the depression of the anterior cornua of the spinal cord. The medullary centres are also depressed, particularly the respiratory and vaso-motor, as shown by the shallow breathing and the fall of blood pressure. Poisonous doses produce complete anæsthesia and coma. The spinal reflexes are abolished and the medullary centres are paralysed—a condition almost identical with chloroform poisoning. Even in progressively larger doses, the pupils remain contracted, till just before death when they get dilated.

Caution.—Chloral hydrate should be cautiously given to persons who are gouty, old and confirmed alcoholics. Children bear chloral well. It is contra-indicated in diseases of the stomach, kidneys, heart and lungs. It must be prescribed with great hesitation to persons who suffer from nervous excitement, hysteria, mania and other diseases of nervous debility. These get addicted to its use and the craving for it is soon generated though not so readily as that of morphine and alcohol. The patient then begins to take larger doses of chloral hydrate on his own account and suffers from chronic poisoning by chloral.

Chloralism or chronic-poisoning by chloral hydrate. The chief symptoms are—gastro-intestinal irritation, a great liability to skin eruptions, dyspnœa, palpitation, mental and bodily weakness.

Physiological antagonists.—Atropine and strychnine counteract the depressing effects of chloral hydrate on the brain and the medullary centres while strychnine, in addition, counteracts its depressing effect on the anterior cornua of the spinal cord.

CHLORBUTOL

Chlorbutol. *Synonym.*—Trichloro-tertiary-butyl-alcohol, Chloretone. It is a white volatile crystalline compound having a camphoraceous odour and taste. It is soluble in water, alcohol, fixed and volatile oils and glycerine.

Dose—5 to 20 grs.—0·3 to 1·2 G.

ACTION AND THERAPEUTIC USES

Locally Chlorbutol when applied to mucous surfaces is both **irritating** and **anæsthetic.** It has a marked **disinfectant** power and is used as a preservative for medicinal products. In the form of spray dissolved in oil it is used as a sedative application to the nose and throat.

For internal purposes chlorbutol was originally introduced as an **hypnotic.** In the therapeutic doses, however, this effect is not marked and in effective doses it produces toxic symptoms. In large doses of 20 or 30 grains, it relaxes muscular spasms and prevents their recurrence, and is, therefore, used as a remedy in tetanus. Chlorbutol as it paralyses the terminations of the sensory nerves in the mucous membrane of the stomach, is often given as a **gastric sedative** to relieve the pain of ulcer of the stomach and gastralgia and to check vomiting, especially that following anæsthesia and in seasickness.

ALDEHYDE GROUP

PARALDEHYDE

Paraldehydum.—Paraldehyde. It is a transparent colourless liquid, having a strong aromatic odour, producing first a burning and then a cooling taste. Soluble in 9 parts of water, freely in alcohol.

Dose—30 to 120 ms.—0·2 to 8 mils.

ACTION AND THERAPEUTIC USES

External.—It is an antiseptic but rarely used.

Internal.—It is extremely irritating to all the mucous membranes and must be given well diluted. It is absorbed rapidly from the stomach and rectum and excreted slowly, chiefly by the lungs. After absorption, it exerts its chief action on the nervous system without affecting the heart and respiration. It depresses the nervous system, chiefly the brain, and acts as a **hypnotic.** In about 10 to 15 minutes, it induces sleep lasting for several hours without any excitement. It is not an analgesic. In toxic doses, it depresses the anterior cornua of the spinal cord. It does not affect the nerves and muscles. **It is a most useful hypnotic for patients suffering from cardiac disease.** Its disadvantages are its disagreeable odour and hot burning taste. It is best administered in brandy and water or in capsules.

SULPHONE GROUP

SULPHONAL

Sulphonal.—Dimethyl-methane-diethyl-sulphone. It occurs as colourless, tasteless crystals, almost insoluble in cold water, but soluble in 15 parts of boiling water.

Dose—5 to 20 grs.—0·3 to 1·2 G.

Methyl Sulphonal.—Di-ethyl-sulphone-methyl-ethyl methane. *Synonym.*—Trional. Occurs in colourless shining acicular crystals with a slightly bitter taste. It is insoluble in water.

Dose—5 to 20 grs.—0·3 to 1·2 G.

ACTION AND THERAPEUTIC USES OF SULPHONAL AND METHYL SULPHONAL

Sulphonal is a pure **hypnotic.** It has no analgesic properties and it does not depress the heart and lungs. Owing to its insolubility it is slowly absorbed, inducing sleep after 1 to 5 hours. Its administration must, therefore, be properly timed. Its excretion being also slow, the effect persists even on the next day and produces drowsiness and depression. It is apt to be **cumulative** and if its administration is continued long, symptoms of sulphonal poisoning supervene. These are manifested in nervous depression, relaxation of spasms of both voluntary and involuntary muscles, and skin eruptions. The appearance of a reddish brown pigment, hæmato-porphyrin (an iron free product of the decomposition of hæmoglobin due to some obscure changes in the liver) in the urine is particularly characteristic. It is excreted partly unchanged and partly as ethyl sulphonic acid by the urine and intestines. Owing to its slow absorption, bad after-effects and cumulative action, it is rarely used. Clinically, however, it is well adapted to combat insomnia caused by mental anxiety, and is particularly effective in that form where the patient cannot sleep when once awakened. It is, therefore, largely used in lunatic asylums where it is necessary to keep maniacs continuously drowsy.

Methyl sulphonal scores an advantage over sulphonal in its solubility and prompt action. Otherwise, it has the same disadvantages. Both the drugs are best given in cachets or in hot milk.

UREA GROUP

HEXOBARBITONE

Hexobarbitonum. *Synonyms.*—Hexobarbital, Evipan, Cyclohexenyl methyl barbituric acid. It is a crystalline powder very sparingly soluble in water so that it is usually given in tablets.

Dose—4 to 8 grs.—0·25 to 0·5 G.

Hexobarbitonum Soluble. *Synonyms.*—Soluble Hexobarbital. Evipan sodium. It is hygroscopic powder, odourless and with bitter taste; readily soluble in water. It contains not less than 95 per cent. of hexobarbital.

Dose—3 to 15 grs.—0·2 to 1 G. by intravenous or intramuscular injection.

Dose—30 to 60 grs.—2 to 4 G. by rectal injection.

ACTION AND THERAPEUTIC USES

Hexobarbital and its soluble salt are certain and rapidly acting **hypnotics.** It is excreted quickly and are less lasting in its effects than Barbitone and hence it has little tendency to depression on the following day. Hexobarbital is used for insomnia, nervous vomiting, epilepsy and pre-operative anxiety.

The solution of soluble Hexobarbital in distilled water (1 gramme in 10 cc.) is injected if slowly, intravenously, if **it acts as a rapid basal narcotic.** During the injection the patient is instructed to count aloud by which the onset anæsthesia is easily appreciated. **It produces within 30 seconds, the surgical anæsthesia** accompanied by a deep yawn, slowing of the respiration and muscular twitching. The corneal reflex is lost and the pupil is slightly dilated. The blood-pressure falls, usually immediately after injection of the drug but soon returns to normal. The pulse is slightly increased. Recovery is rapid, but the speed depends upon the dosage, generally consciousness returning in about 10 minutes. There are no dependable eye-signs available as a guide to depth of anæsthesia, but the reaction to pinch of the skin is a valuable sign.

Soluble Hexobarbital is of great value for producing anæsthesia for short surgical and dental operations and for manipulative work in minor surgery.

BARBITONE

Barbitonum. *Synonyms.*—Diethylbarbituric acid. Barbital, Veronal. It occurs as a crystalline powder with a slightly bitter taste. Sparingly soluble in cold water, more in hot and in alcohol and freely in aqueous alkaline solutions.

Dose—5 to 10 grs.—0·3 to 0·6 G.

Barbitonum Solubile.—Soluble Barbitone. *Synonym.* Veronal Sodium. Obtained by the interaction of Barbitone and Sodium Hydroxide. It contains not less than 9·7% of Barbitone.

Dose—5 to 10 grs.—0·03 to 0·6 G.

Action and Therapeutic Uses

It is a powerful **hypnotic,** inducing sleep within half an hour or an hour without any after-effects. In medicinal doses, it produces no gastro-intestinal disturbance, nor does it depress the heart and lungs. In larger doses, it depresses the respiratory centre, increases the secretion of the bronchi and even causes œdema of the lungs. Death is generally due to the failure of respiration. It is excreted slowly and may produce serious cumulative effects such as impaired mentality, ataxia, debility, gastro-intestinal irritation, anæmia, hæmatoporphyrin and erythematous rash. Most of it is excreted in the urine and may act as a diuretic.

PHENOBARBITONE

Phenobarbitonum. *Synonym.*—Phenobarbital, Luminal Phenyl-ethyl-barbituric acid. It occurs as a white, odourless powder, with a faintly bitter taste. It is insoluble in water, but readily soluble, in alcohol, chloroform and ether and in dilute alkalies.

Dose—½ to 2 grs.—0·03 to 0·12 G.

Phenobarbitonum Solubile.—Soluble Phenobarbital. *Synonym.*—Luminal Sodium. It occurs as a white crystalline hygroscopic powder, readily soluble in water. It contains not less than 95 per cent. of phenobarbital.

Dose—½ to 2 grs.—0·03 to 0·12 G.

Action and Therapeutic Uses

Luminal and its soluble salt are powerful **hypnotics** and are active in little more than half the doses of the other hypnotics of the urea group ; but they are correspondingly more toxic in effect. In medicinal doses, they do not produce any gastro-intestinal disturbance nor do they depress the heart and lungs. In large doses they cause the blood pressure to fall by their direct depressing action on the heart and also by dilating the peripheral blood vessels. Luminal has been extensively used in psychiatric practice to calm the excitement and delirium of the insane. Luminal-Sodium being soluble could be administered by injection for this purpose. Recently, experience has shown that it is a useful remedy for the **treatment of epilepsy** and **migraine** as it reduces the frequency of attacks. It can be administered daily in small doses as it has no cumulative action. But after a time the tolerance for the drug is established and the dose requires to be increased. In fractional doses, it acts as an **antispasmodic** and is used in bronchial and cardiac asthma, in angina pectoris, whooping cough and laryngeal spasms.

PHEMITONE

Phemitonum. *Synonym.*—Prominal. It occurs as a white crystalline powder almost insoluble in water but soluble in alcohol (90 per cent.)

Dose—½ to 6 grs.—0·03 to 0·4 G.

THERAPEUTIC USES

Phemitone is used chiefly in the treatment of epilepsy. It has this advantage over luminal that the patient is not kept drowsy.

CARBROMAL

Carbromalum.—Bromo-ethylbutryly carbamide. *Synonyms.*—Uradal; Adaline. A white crystalline powder, almost odourless and tasteless. Insoluble in water, soluble in 18 parts of alcohol (95 per cent.), 14 parts of ether and 3 parts of chloroform.

Dose—5 to 15 grs.—0·3 to 1 G.

ACTION AND THERAPEUTIC USES

Carbromal is the least toxic of the hypnotics of the urea group. It is slowly absorbed into the system and is partially broken up in the system into inorganic bromide and thus acts as a nervine sedative and analgesic. As a hypnotic, it is of particular service when sleeplessness is due to worry or emotional disturbance of any sort. It calms the excitement of hysteria, neurasthenia, mania and anger. It will not induce sleep when given in cases of severe pain or in great maniacal excitement.

URETHANE

Urethanum. *Synonym.*—Ethyl carbamate which occurs as white crystals, odourless; with saline bitter taste is soluble in water and alcohol.

Dose—15 to 30 grs.—1 to 2 G.

Injectio Quinæ et Urethani.—It contains 12·5 per cent. of quinine hydrochloride, 6·25 per cent. of urethane.

Dose—8 to 75 ms.—0·05 to 5 mils. by intravenous injection as a sclerosing agent.

ACTION AND THERAPEUTIC USES

Urethane is a *mild hypnotic*. It is rapidly absorbed and completely broken down in the body. It does not depress the heart or respiration and is excreted as urea which acts as a diuretic. It is used with quinine into varicose veins **as a sclerosing agent.**

B. CEREBRAL DEPRESSANTS

GENERAL ANÆSTHETICS

General Remarks.—The general anæsthetics of the B.P. are Hydrocarbons of the fatty series and like Benzol Compounds these resemble each other closely in their main actions. They produce local anæsthesia by evaporations and, if evaporation is prevented, they act as irritants. The most conspicuous effect they produce on higher animals consists of narcosis or anæsthesia of central origin, that is, they produce " a physiological condition in which the normal responsiveness or automatic activity of the living system—organism, tissue or cell—is temporarily decreased or abolished." The various theories explaining their mode of action are detailed on page 96.

ALCOHOL

Alcohol. (95 per cent.).—It is a mixture of ethyl alcohol and water obtained by the distillation of fermented saccharine liquids. It is a colourless, transparent, mobile, volatile liquid, having a burning taste and characteristic spirituous odour. It burns with a blue smokeless flame, and is miscible in all proportions with water, with ether and with chloroform. It is used in various dilutions with water in preparing official diluted alcohols. On mixing alcohol with water, contraction of volume and rise of temperature occurs. The mixture must, therefore, be allowed to cool before it is employed for use in the B. P.

Alcohol Dehydratum.—Dehydrated Alcohol. *Synonym.*—Alcohol Absolutum. Obtained by the dehydration of alcohol (95 per cent.), and subsequent distillation. Its characteristics are similar to those of Alcohol (95%). It contains 99 per cent. by weight of alcohol and one per cent. by weight of water.

Dilute Alcohols. The official alcohols of various percentage are obtained by diluting alcohol (95 per cent.) to 1 litre with distilled water till the specific gravity of the mixture reaches the specific gravity required for the particular dilution. The final adjustment of the volume is made when the temperature cools down to about 15° C.

1. **Alcohol (90 per cent. by volume).** *Synonym.*—Spiritus Rectificatus; Rectified Spirit.—Sp. gr. 0·832 to 0·835.
2. **Alcohol (80 per cent. by volume).**—Sp. gr. 0·863 to 0·865.
3. **Alcohol (70 per cent. by volume).**—Sp. gr. 0·889 to 0·891.
4. **Alcohol (60 per cent. by volume).**—Sp. gr. 0·913 to 0·914.
5. **Alcohol (50 per cent. by volume).**—Sp. gr. 0·934 to 0·935.
6. **Alcohol (45 per cent. by volume).**—Sp. gr. 0·943 to 0·944.
7. **Alcohol (25 per cent. by volume).**—Sp. gr. 0·9705 to 0·9713.
8. **Alcohol (20 per cent. by volume).**—Sp. gr. 0·9755 to 0·9765.

Spiritus Methylatus Industrialis.—Industrial methylated spirit. It is a mixture of 19 volumes of alcohol (95 per cent.) with 1 volume of approved wood naphtha. It is used externally and not internally.

Besides these, there are many alcoholic beverages containing various percentages of alcohol, mainly depending upon the mode of their manufacture, which is either of distillation or of fermentation.

Distilled spirits, such as brandy, whisky, and gin, which are obtained from the mash of fermented grain, and rum from molasses, contain about 50 to 60 per cent. of alcohol by volume.

Fermented spirits may be obtained from grapes and malt. Those obtained from the expressed juice of grapes are called wines and cannot contain more than 15 per cent. of alcohol as the process stops when that concentration is reached. Their percentage varies with the time allowed for fermentation. Light wines, such as burgundy, hog, claret, champagne, contain 9 to 11 per cent. of alcohol by volume. Heavy wines, such as sherry, port, and medeira, contain a maximum percentage of full fermentation and in addition a small quantity of extra alcohol is added so as to bring the percentage of alcohol by volume to 19 to 23.

Beer, porter, stout, and ale are obtained by slow or rapid fermentation of malt by means of heat, and contain 3 to 7 percentage of alcohol by volume. They are the most nutritive of all the alcoholic preparations, as they contain a large percentage of carbo-hydrate. They are slowly absorbed owing to the collodial nature of their constituents.

ACTION OF ALCOHOL

External.—Alcohol is an **antiseptic** acting by precipitating the proteins. When applied to the skin and allowed to evaporate, it produces a sensation of coldness, constricts the blood vessels with consequent lessening of sweat, and depresses the sensory nerve endings. Alcohol thus acts as an **astringent, refrigerant, anhydrotic** and **anæsthetic.** If evaporation of alcohol is prevented or rubbed in strong solution, it penetrates into the skin, produces a sensation of warmth and burning, and dilates the blood vessels. It thus acts as a local **stimulant, a rubefacient and a counter-irritant.** If rubbed continuously, it abstracts water from the skin and makes it hard.

Internal.—*Alimentary Tract.*—Strong alcohol in the mouth causes a burning sensation followed by anæsthesia. It causes a white coating on the mucous membrane by coagulating albumen; but the coagulum is quickly dissolved by the fluids of the tissues. It reflexly increases the flow of saliva and gastric juice by the stimulation of the sensory nerve endings in the mouth. In the stomach, the action of alcohol varies with the quantity and the concentration. Well **diluted alcohol** in moderate quantity dilates the gastric vessels, increases the secretion of the gastric juice, regulates the movements of the stomach and promotes absorption. It thus acts as a **gastric stimulant** and a **carminative.** It may in some cases act as a local **anæsthetic** to relieve gastric pain, A quantity of alcohol, mixing with the contents of the stomach, is decomposed into aldehydes and acetic acid, and precipitates some of the pepsin, peptones and proteins. It may thus depress digestion but the total effect of a moderate dose of alcohol is to stimulate gastric digestion. In concentrated form or in large diluted doses, the activity of the gastric juice is impaired, the gastric walls are inflamed causing excessive secretion of mucous, and if over-indulgence is continued, chronic gastritis ensues, the gastric glands atrophy and dyspepsia become permanent. These inflammatory changes extend to the portal system and may cause inflammation leading to cirrhosis and fatty degeneration of the liver.

In the intestines, alcohol is said to act as an **astringent** and check diarrhœa. It increases the secretion of the pancreas by the increased formation of secretin. The digestion of a moderate dose of strong alcohol acts as a prompt **diffusible stimulant** by reflexly stimulating the heart to beat rapidly and forcibly. It dilates the blood vessels especially those of the skin, and produces a feeling of warmth. This reflex action is further kept up by its absorption into the circulation.

Absorption and Elimination.—Alcohol is rapidly absorbed from the stomach and intestines. It appears in the blood in about a few minutes and reaches its maximum concentration in about an hour or two. This absorption, however, is greatly modified by the dilution in which it is taken and by the amount of food in the stomach. There is a quicker absorption from concentrated solution than from the diluted one. It is greater when taken over an empty stomach than over a loaded one. Most of the alcohol ingested is destroyed in the body, only about 2 per cent. being excreted unchanged in the urine and breath.

Blood.—Alcohol in the blood binds the oxygen more firmly to the hæmoglobin and thus interferes with the oxidising properties of the red blood corpuscles and diminishes, after preliminary increase, the amœboid movement of the white blood corpuscles.

Circulatory System.—Apart from the reflex stimulation of the heart, obtained by the depression of the vagus control through the irritation of the stomach, alcohol by improving the nutrition of the heart, either by the dilatation of the coronary artery or by its general nutrient effect, stimulates the heart, constricts the systemic and dilates the peripheral vessels by its central action, and raises the blood pressure. In larger doses, alcohol poisons the circulatory system. It dilates all the vessels of the body, reduces the force and contractions of the heart and causes blood pressure to fall.

Respiratory System.—It stimulates the respiratory system and increases the rate and depth of respiration either directly or reflexly through the irritation of the stomach or more probably through the increased loss of heat caused by alcohol which is compensated by the extra intake of the oxygen necessary for increased combustion. Toxic doses depress the respiratory centre.

Skin.—Alcohol by its vaso-dilator action on the superficial blood vessels of the skin and by its stimulant effect on the sweat glands, acts as a **diaphoretic** and increases the loss of heat. This effect produces a general feeling of comfort in a warm atmosphere, but in an extremely cold atmosphere, if alcohol is taken to produce the sensation of warmth to prevent chill, it proves harmful by cooling the blood beyond its normal limits. There is increased loss of heat by the radiation of the blood, and the evaporation of sweat, and diminished production of heat owing to the retarded oxidation. The general effect of this is to lower the resisting power of the body, which may ultimately prove fatal.

Temperature.—Alcohol acts as an **antipyretic** by increasing the loss of heat by radiation and diaphoresis. It may also act by depressing the heat regulating centre.

Kidneys.—Alcohol, especially in the form of gin, acts as a **diuretic** by dilating the renal vessels.

Nervous System.—The immediate effect of alcohol when taken in a moderate and well diluted quantity is stimulation. The imagination becomes brilliant, the intellect clear, and the senses acute. There is increased vivacity of motion, action and speech ; the subject exhibits more of self-confidence but less of self-control ; and according to temperament, a jovial person becomes hilarious and talks and laughs on the slightest provocation ; a moody person becomes melancholic ; while an emotional one begins to cry. With larger and often repeated doses, stimulation passes on to depression. The mind becomes cloudy. The control of muscles becomes less and less, making the gait unsteady and skilled muscular movement impossible. The speech becomes incoherent, thick and muttering. Later on all muscular activity is paralysed. A state is reached where all the reflex centres in the cord are paralysed. The urine and fæces are passed involuntarily. The vital centres in the medulla then get depressed and breathing becomes stertorous and slow. The face becomes pale and cyanosed and ultimately death results from respiratory failure. Alcohol in presenting these actions on the central nervous system follows the law of dissolution like other narcotics (see page 91), and stimulates or depresses the nervous system in an evolutionary order, picking up those centres first, which are developed last. The controversy about the action of alcohol, however, centres round the second law of narcotics, *viz.*, "initial stimulation and then depression." According to Binz and his followers, alcohol obeys this the law and all the actions of the brain and the spinal cord are explainable on this basis. But Schmiedberg and his followers, according to their researches, maintain that alcohol depresses from the start the functions of the brain. The stimulant effect of alcohol, they assert, is really apparent and is due to the depressing action of alcohol on the psychic centres of the faculties of judgment, reflection, observation and attention, which have been developed by education and which have a controlling influence over the reflex activities. When this controlling is done away with, the subject becomes more childlike, impulsive and emotional. He loses his fear of consequences, his shyness and self-control; and he behaves in a manner of which, normally, he would be ashamed.

Metabolism.—Alcohol enters the blood unchanged or as an aldehyde and reaches the tissues and organs. There it is oxidised into carbonic acid gas and water. It thus becomes a source of heat and energy like the decomposition products of the fats and carbohydrates of our foodstuffs and **it spares the combustion of the carbohydrates and fats.** The body, therefore, shows a corresponding increase in weight, which is particularly seen in the stout appearance of those addicted to its use. Though alcohol itself is oxidised in the body, it interferes with the oxidation of other substances and saves the body from general wear and tear. In persons not addicted to alcohol, the breaking down of tissue proteins is at first increased, but when the tolerance is established by its continued use, **protein metabolism is also spared,** as can be seen in the diminished output of urea and uric acid in the urine.

Alcohol as a Food.—Though alcohol supplies by its combustion the necessary heat and energy to the body and acts as a typical non-nitrogenous food which does not require previous digestion, yet it is **not a true food,** since it is not stored up in the body, like fats and carbohydrates, to supply the energy available from its decomposition for future needs. Nor is the energy derived from its combustion adjustable to the energy requirements of the body, as the combustion rate of alcohol both at rest and in exercise is constant. It is about 10 c.c. per hour in an adult, however high the concentration in the blood may be. Any excess above this rate of combustion circulates in the blood as such and produces its poisonous effects on the tissues. Alcohol, therefore, **acts as a food within the limits of its oxidation, and as a drug when that limit is exceeded.**

Tolerance.—The tolerance for alcohol is a complex process and nothing definite is as yet said about it. It may be due to the body acquiring increasing powers of oxidising alcohol by its continued use, or it may be due to the more delayed absorption in the blood of an alcoholic, than in a normal, person. Larger quantities of alcohol are tolerated by persons, in a state of exhaustion following fevers and operations, from its utilization in the body as a food. Alcohol, however, is not a powerful habit forming drug as its sudden deprivation does not show any physical signs of reaction.

THERAPEUTIC USES

Alcohol is used externally in the form of a lotion in sprains, and inflammations of the skin, and to check perspiration. It is used to harden the skin in threatened bedsores, cracked nipples, etc. As an antiseptic and disinfectant, it is used for sterilizing the skin before an operation, delicate instruments, hypodermic syringes and surgeon's hands. Internally, it is used as a diffusible stimulant and carminative in various diseases of the stomach, and of the heart, and as a food in fevers and convalescence, etc. It is sometimes given in sleeplessness, neuralgia and melancholia. Alcohol is also given in wasting diseases like phthisis. In acute fevers, it is employed to strengthen, soften and frequent the pulse, to sustain the heart and nervous system, to lessen delirium, to moisten the dry brown tongue, to reduce temperature by promoting the loss of heat and to aid digestion. If these objects are not fulfilled alcohol should be discontinued.

CHLOROFORM

Chloroform.—Chloroform. A clear mobile liquid with a sweetish aromatic odour and burning taste, sparingly soluble in water, but readily in alcohol and in fixed oils.

Dose—1 to 5 ms.—0·06 to 0·3 mil.

1. **Aqua Chloroformi.**—A saturated solution of chloroform in distilled water, *i.e.*, about 0·25 per cent.

Dose—½ to 1 fl. oz.—15 to 30 mils.

2. Spiritus Chloroformi.—Contains 5 per cent. chloroform in alcohol (90 per cent.).

Dose—5 to 20 ms.—0·3 to 2 mils.

3. Emulsio Chloroformi.—It contains 5 per cent. chloroform, with a liquid extract of quillaia, mucilage of tragacanth and water.

Dose—5 to 30 ms.—0·3 to 2 mils.

ACTION OF CHLOROFORM

External.—Chloroform has very nearly the same action as alcohol has. If applied to the skin and allowed to evaporate, it produces a sensation of coldness which constricts the blood vessels and depresses the terminations of the sensory nerves. It thus acts as a **local anæsthetic.** If the vapour be confined or if chloroform be rubbed on the skin, it irritates, reddens and blisters the skin and produces a burning sensation. It thus acts as a **counter-irritant,** and is a powerful **antiseptic** and general protoplasmic poison.

Internal.—*Alimentary Tract.*—In dilute form,chloroform has a sweet burning taste and causes reflex salivation. In the stomach, it acts as a **stomachic** and **carminative.** In the intestines, it has a sedative and **astringent** action, particularly in combination with opium. In large quantities or undiluted, it acts as a gastro-intestinal irritant. Like alcohol, it reflexly stimulates the heart.

Absorption and Elimination.—Chloroform enters the circulation through the stomach and intestines, and from the lungs when the vapour is inhaled. It is carried by the red blood corpuscles to the tissues and exerts its most important action on the central nervous system. Some of the chloroform absorbed is eliminated by the lungs, urine, saliva, stomach and the skin. A small amount is oxidised in the body as could be seen by the increase it causes in the acidity and chlorides in the urine which reduces Fehling's Solution like that of sugar.

Blood.—Chloroform inhibits the amœboid movement of the white blood cells and may cause hæmolysis of the red blood corpuscles.

Metabolism.—Chloroform, if inhaled for a long time, destroys the tissue proteins and interferes with oxidation. Consequently there is an increased appearance of nitrogen and sulphur in the urine, but their destruction is not complete as the quantity of urea in the urine is not increased. It disturbs the dissolution of fat and its repeated administration produces the fatty degeneration of the liver, heart and kidneys, which ultimately leads on to fibrosis of the same organs. Carbohydrate metabolism is also altered, as acetone and sugar appear in the urine, making its administration unsuitable in diabetes.

Nervous System.—Chloroform is mainly used for its anæsthetizing effect. When inhaled, it causes the progressive paralysis of the central nervous system and forms an excellent instance illustrating the two laws of "dissolution" and of "initial stimulation and then depression." For its anæsthetizing effect chloroform is generally administered with air in concentration of 0·2 to 0·5 per cent. (by volume) and if administered in concentration over this limit, it may lead to dangerous symptoms. The anæsthetizing phenomena is divided by some into three and by others into four stages. **In its various stages it affects consciousness, heart, respiration, the pupil and skin differently :—**

The first stage is of local action and disordered consciousness. Chloroform vapour, when inhaled, irritates the nasal mucous membrane, causing reflex salivation and coughing. There is a voluntary withholding of breath till forced to breathe by asphyxia and the slowing of the heart. The last two reflex phenomena are due to the irritation of the endings of the fifth nerve in the nasal mucous membrane and do not occur if these are painted with some local anæsthetic. Coincidently with this there is the stimulation of the higher functions of the brain. Imagination and feelings become exalted, and to some extent, confused. Senses are soon disordered and depressed. The pulse is quickened, the face is flushed and **the pupils are dilated.** This stage is soon followed by the next.

The second stage is marked by the loss of consciousness accompanied by unconscious reflex activity which is manifested in struggling. In this stage the organs of sense become dull and the subject is no longer conscious of external impressions. He chatters wildly and incoherently and according to temperament may sing, or cry or shout. Coincidently with this psychic depression, the lower motor centres are stimulated and struggling ensues. The respiration becomes irregular, the pulse is accelerated and **the pupils remain dilated,** on account of the stimulation of the sympathetic nerves. This state soon merges into the next.

The third stage of surgical anæsthesia, which is characterised by the paralysis of all the nerve centres, which have been previously stimulated, and the abolition of all reflex activity, the pupillary reflex being the last to disappear. There is a complete relaxation of all voluntary muscles. The pulse is full, regular and slow. Respirations become slower and shallower, but noisy and stertorous, and as a result there is considerable diminution in the respiratory exchange. The blood pressure falls. **The pupils get contracted** owing to the stimulation of the third nerve or its centre, and they do not react to light. If the administration of chloroform vapour is pushed beyond this stage—

The fourth stage of medullary paralysis or the " stage of collapse " ensues, in which the involuntary muscles lose their tone and the patient involuntarily passes urine and stool. The skin and mucous membranes get cyanosed due to asphyxia caused by the paralysis of the respiratory centre. The contractions of the heart become feeble and irregular owing to the poisonous effects of oversaturation on the heart muscles. The pulse becomes feeble and intermittent. The vaso-motor centre is also paralysed causing dilatation of the blood vessels and fall in the blood pressure. The skin becomes pale, cold and is covered over with perspiration. The **pupils remain widely dilated** due to the paralysis of the third nerve and the patient dies either of cardiac or respiratory failure.

It will be observed that there is a close resemblance between alcohol and chloroform narcosis. Chloroform, however, causes wilder excitement owing to the rapidity of its action.

Recovery from chloroform anæsthesia takes place in the reverse order of depression, and thereby once again it illustrates the law of dissolution. The first sign of recovery is the dilatation of the previously contracted pupil, and the return of corneal reflex. After a while, the patient regains muscular tone and later on consciousness.

Death during Anæsthesia.—A sudden death may occur during the progress of chloroform anæsthesia. It is common during the stage of induction and in the later stage of prolonged anæsthesia. After a few minutes of its administration, when the body is hardly saturated with chloroform vapour, the heart suddenly stops without any premonitory symptom. The respiration continues for a few seconds and death occurs. The cause of this is attributed to the stimulation of the vagus centre either directly or reflexly through the irritation of the nasal or respiratory mucous membranes by chloroform vapour. Normally this sudden inhibition of heart's action by the reflex stimulation of the vagus centre does not go beyond lessening the number of heart beats, but when the chloroform vapour is circulating through the blood, **it sensitizes the heart,** and the inhibition of heart's action is permanent. As death may also occur when all reflex paths are eliminated, it has been suggested that the absorption of a concentrated dose of chloroform vapour from the great surface of pulmonary capillaries excites the vagal centre and inhibits the action of the heart. This inhibition of heart's action through the stimulation of the vagus system is called "**the vagal type of heart collapse**" and may be prevented by the administration of Atropine (1/200 to 1/100 gr.)—an alkaloid which paralyses the vagal endings—before the patient is anæsthetised, thereby blocking the central impulse. Another type of cardiac failure in the early stage of anæsthesia is to be found in the fibrillations of the ventricles, induced by sensory stimulus or by the increased secretion of adrenalin, in an already excited heart due to the irritant action of chloroform vapour on the accelerator nerve endings in it. The fibrillations interfere with the pumping action of the heart, which ultimately stops in diastole. This is called **"the sympathetic type of cardiac collapse."** It is serious and the massage of the heart and artificial respiration are the only means to revive it.

During the late stage of anæsthesia, death may occur from the high concentration of chloroform vapour in the blood. It directly poisons the myocardium and enfeebles its contractions ; at the same time there is paralysis of the respiratory and vaso-motor centres. Death may occur by respiration failing first or by the simultaneous failure of the heart and respiration. Some authorities, however, maintain that it is the respiration that fails first for the want of proper blood supply to the respiratory centre by the failing heart.

Delayed Poisoning.—Besides these deaths during the progress of anæsthesia, chloroform is also directly responsible for death occurring within a few hours or days after the narcosis. These are due to delayed chloroform poisoning and are common in young subjects after an operation requiring prolonged administration of chloroform. This induces fatty degeneration in the liver, heart and kidneys. Symptoms of acidosis supervene, which begin with vomiting, and delirium and end in coma. Blood sugar is diminished and the urine contains acetone and diacetic acid. This delayed poisoning could be prevented by giving a carbohydrate diet a few hours before the induction of anæsthesia or by the injection of 5 per cent. glucose solution.

Precautions Before and After the Administration of

Chloroform.—To prevent all possible chances of mishap and to reduce the risk of chloroform poisoning to a minimum, the following points should be attended to :—

1. Selection of patient. All patients are not suitable for inducing chloroform anæsthesia. Anæmic persons, patients suffering from fatty degeneration, dilatation or valvular diseases of the heart, extensive diseases of the lungs and respiratory passages and diabetics are all unsuitable for chloroform anaesthesia. It should be cautiously administered to children, old, debilitated persons and epileptics.
2. No solid food should be allowed at least four to six hours before the operation. The presence of food in the stomach may induce vomiting, and the vomited matter is likely to enter the larynx in the semi-unconscious state of anæsthesia and cause death by suffocation.
3. All tight clothes about the neck, chest and abdomen should be removed or loosened to help free respiratory movement.
4. False teeth should be removed.
5. A nervous patient should be brought into a calm state of mind and, if necessary, an injection of morphine should be tried before the commencement of anæsthesia.
6. Before anæsthetizing, the face of the patient be smeared with vaseline to prevent the delicate skin being irritated from chloroform vapour.
7. If Junker's inhaler is to be used for the administration of chloroform vapour, a few whiffs should be tried away from the patient to see that the bellows is attached to the proper side, that is, to the metal tube which reaches the bottom of the bottle. If

fixed to the wrong side, the whole of the chloroform in the bottle will be pumped out over the face of the patient.

8. The chloroform used must be pure. The vapour must be freely diluted with air. Its concentration may be regulated by holding the mouthpiece of the inhaler close to the face when the respiration is shallow, and removing it to some distance when the patient begins to breathe deeply.
9. To begin with, it is advisable to start with a less concentration of chloroform vapour, as it is less unpleasant, incites less struggling and prevents sudden stoppage of the heart in the early stage of induction.
10. No operation, however trivial, should be undertaken until the reflex action is completely abolished, as shown by the abolition of the corneal reflex, which is the last to disappear. If this precaution be not observed, it may cost the life of the patient by the stimulus of the surgeon's knife reflexly stopping the heart.
11. Keep the patient well covered and warm, as there is generally a fall in temperature during anæsthesia.
12. An anæsthetist should give his undivided attention to the pulse, respiration, pupil, corneal reflex and the colour of the face. Symptoms of an overdose of chloroform vapour are quickly manifested by them and if it be so, the administration of chloroform should be suspended. Pallor of face and stertorous breathing should be at once controlled by turning the face to one side, depressing the lower jaw, raising the shoulders, opening the mouth and pulling out the tongue. If the respiration threatens to stop, artificial respiration should be commenced, and inhalation of amyl nitrate should

be tried. Intracardial injections of Adrenaline, or subcutaneous injections of brandy, strychnine, ether should be tried to revive a failing heart. It may be mechanically stimulated by thrusting fingers under the ribs or by flicking the chest over the heart with hot towels or by placing hot compress over it. Electricity may also be applied over the cardiac region.

THERAPEUTIC USES

Chloroform is used to relieve neuralgia and toothache. In the form of liniment either pure or in combination with Linimentum Belladonnæ and Aconite, it is largely used in myalgia, lumbago, pleurisy and chronic rheumatism. Internally, in the form of spiritus chloroformi, it is used as a sweetening agent to disguise the unpleasant taste of drugs, and as a gastric sedative and carminative. In combination with opium, it is used to check diarrhœa and as a remedy in cholera. As a general anæsthetic it is used in surgical operations, to relax muscular spasms in cases of dislocations, and abdominal examinations; to relieve the pain of parturition and biliary and renal colic; and to quiet the body during convulsions as in tetanus, hydrophobia and strychnine piosoning.

ÆTHER

Æther.—Ethylic Ether or Ethyl Oxide. *Synonym.*—Sulphuric Ether. A transparent, colourless mobile liquid having a characteristic odour and burning taste. It is highly volatile and inflammable; sparingly soluble in water, but freely in alcohol and fixed oils.

Dose—15 to 60 ms.—1 to 4 mils.

Spiritus Ætheris.—Admixture of ether and alcohol (90 per cent.) in proportion of 1·2.

Dose—15 to 60 ms.—1 to 4 mils.

Æther Anæstheticus. *Synonym.*—Æther Purificatus. Æther deprived of all its impurities; employed for anæsthesia

ACTION OF ETHER

External.—Ether acts like alcohol, but being more volatile it produces a greater sensation of coldness and numbness on account of rapid evaporation. It thus acts as a **refrigerant** and a **local anæsthetic.** Its local anæsthetic effect is best obtained by spraying. The part freezes, gets benumbed and no sensation of pain is felt. If evaporation is prevented, it acts as a rubefacient and vesicant. It is an **antiseptic.**

Internal.—*Alimentary Tract.*—In the mouth, it has a strong burning taste, irritates the mucous membrane and causes reflex salivation. In the stomach, it causes increased secretion of gastric juice and regulates its movement. It thus acts as a **gastric stimulant** and **carminative.** In narcotic doses, it delays the emptying of the stomach and paralyses the intestinal movements. It reflexly stimulates the heart, respiratory organs and the intestines and raises the blood pressure. It is a **diffusible stimulant** and an **antispasmodic.**

Absorption and Elimination.—Ether is probably not absorbed from the intact skin, yet it is taken up freely from all mucous surfaces. Its rapid absorption, however, could only be obtained through the lungs by inhalation or from the mucous membrane of the rectum and colon. If forced into the rectum as vapour or injected mixed with oil, a true surgical anæsthetisia could be obtained. The elimination of ether takes place wholly from the lungs. None is destroyed in the body but traces of vapour are found in all excretions and secretions, enough at least to give these an ætherial odour. Its elimination could be hastened by increasing the volume of respiration or by the inhalation of carbon-dioxide gas which increases this.

Nervous System.—When inhaled, it produces the same anæsthetic effect on the nervous system as that of chloroform. The salient feature of chloroform anæsthesia described in the foregoing pages apply also to ether. But there are certain marked differences between the action of the two drugs which are tabulated here below :—

	ETHER	CHLOROFORM
1.	Ether is administered with air in concentration of 70%.	Chloroform is administered with air in maximum concentration of 2%.
2.	It is highly inflammable, therefore its use is restricted during day and no flame is allowed near the field of operation.	Chloroform is not inflammable.
3.	The stage of anæsthesia is shorter and the degree less profound.	The stage of anæsthesia is more complete and the degree more profound.
4.	Cardiac, respiratory and vaso-motor centres are not readily paralysed ; therefore ether is safer.	Cardiac, respiratory and vaso-motor centres are paralysed ; therefore, chloroform is less safe.
5.	A large quantity is required to produce anæsthesia 4 to 6 fl. drs. to several fl. ozs.	A small quantity, 1 to 4 fl. drs. is enough.
6.	The smell is disagreeable.	The smell is pleasant.
7.	The after-effects as bronchitis, vomiting are frequent and severe.	After-effects less frequent and not severe.
8.	Elimination is slow and protracted.	Elimination is rapid.
9.	No risk of delayed poisoning.	There is every risk of delayed poisoning.
10.	Fall of temperature during anæsthesia is great.	Fall of temperature is only slight.

11.	**Paralyses** the nerve endings of voluntary muscles and the blood pressure is high.	Paralyses the nerve endings of voluntary muscles and the blood pressure is low.
12.	Death takes place by stoppage of the circulation and respiration remaining unaffected.	Death takes place primarily from the failure of circulation or both circulation and respiration fail simultaneously.

Caution.—Though ether is a safer anæsthetic, yet in an operation which must be hastily undertaken and completed, in parturition and other cases when profound anæsthesia is not necessary, chloroform is preferable. Infants bear chloroform better as it is less irritant to their delicate respiratory passages. Ether vapour coming in contact with the parts to be operated upon, favours bleeding. It is, therefore, not a suitable anæsthetic for operations to be done round about the region of the mouth and face.

THERAPEUTIC USES

Ether is applied externally as a refrigerant and local anæsthetic in the form of spray to relieve the pain of neuralgia and to prevent pain in minor surgical operations. It is also used as an antiseptic in infected wounds. Internally, it is given as a carminative in colic, and as an antispasmodic in hiccough and asthma. It is often used as a reflex stimulant in faintness, syncope and in weakness of the heart from various causes. Sweet spirit of nitre is used as a diuretic and diaphoretic, acting by relaxing and dilating the cutaneous vessels.

ETHYL CHLORIDE

Æthylis Chloridum. *Synonym.*—Kelene, Hydro-chloric ether. It is colourless, mobile, very volatile, liquid at low temperature or under pressure. For use, it is put up in glass tubes with a very fine point for an opening which is protected by a stopper. When the stopper is opened, the fluid volatilizes and comes out in a fine jet and condenses on the part on which it is sprayed.

ACTION AND THERAPEUTIC USES

Ethyl Chloride is both a **local** and a **general** anæsthetic. On account of its great volatility and consequent rapid evaporation, it is used in the form of a spray to produce intense cold sufficient to freeze the superficial tissues and to cause local anæsthesia, which is utilized in minor surgical operations and in the relief of neuralgic pains. When inhaled, it resembles chloroform in its action and depresses the heart like chloroform, but less powerfully. It is the most rapidly acting of the anæsthetics; unconsciousness being produced within ½ to 1 minute. It is, therefore, used to produce primary anæsthesia, which afterwards is kept up by the administration of chloroform. Since recently it is used for the cure of ringworm. The affected part is sprayed with ethyl chloride after the surface has been washed with a solution of bicarbonate of soda and spirit of ether. It is more effective if the part is painted with tincture of iodine before spraying.

ETHYLENE

Æthylenum.—It is a colourless gas with a sweetish taste and odour. It is somewhat lighter than air, and is inflammable. A mixture of ethylene and oxygen or air in certain concentration is explosive. It is soluble in 9 volumes of water at 25° C. For convenience in use, it is compressed in metal cylinders.

ACTION AND THERAPEUTIC USES

Ethylene, in concentration of 90 per cent. and 10 per cent. of oxygen is used specifically for its anæsthetic effects on the central nervous system. On inhalation the gas presents the same stages as other inhalation narcotics, but their duration is short as complete surgical anæsthesia can be produced much earlier than by the administration of either chloroform or ether. Its combination with oxygen prevents asphyxia or dyspnœa. **Like ether, ethylene does not irritate the respiratory passages.** Recovery after its administration is rapid and the disagreeable after-effects, such as nausea and vomiting, are slight. As it induces analgesia even before the complete loss of consciousness, it is largely used for minor operations which do not require complete surgical anæsthesia, as in the opening of an abscess or the incising of a carbuncle. Its disadvantages are that it is inflammable like ether and it forms explosive compounds with air or oxygen in certain proportions.

ACETONE

Acetonum. *Synonym.*—Dimethyl-Ketone. A clear, colourless, mobile and volatile liquid, with a characteristic odour and a pungent sweetish taste. It is inflammable. It is used as a solvent for cantharidin in Liquor Epispasticus.

Action and Therapeutic Uses

It is a feeble narcotic causing considerable dyspnœa. It is mainly used as a solvent for resins, fats, rubber, celluloid, etc.

NITROUS OXIDE

Nitrogenii Monoxidum. *Synonym.*—Laughing gas. It is a colourless, odourless gas supplied in the liquid form in steel cylinders under a pressure of 50 atmosphere. It is not a carbon compound, but is considered here for convenience.

Action and Therapeutic Uses of Nitrous Oxide

Nervous System.—Nitrous Oxide, or Laughing Gas as it is called, is used specifically for its **anæsthetic** effect on the central nervous system. It acts by causing asphyxia by the exclusion of oxygen and by depressing the central nervous system by its easy solubility in the fats there. It is administered through a tight fitting mask so that all air is excluded. After inhalation the gas presents the same stages as other inhalation narcotics, but their character is different and the duration very short as the complete surgical anæsthesia could be produced within 3 or 4 minutes of its administration.

The first stage lasts about 30 seconds. It is characterised by numbness and exhilaration with a sense of suffocation. The respiration is deeper and quicker and the pulse fuller. It is soon followed by—

The second stage which lasts about a minute or two and is characterised by incoherent talk, which is often accompanied by laughter. The patient is subject to dreams and there is partial loss of consciousness. The respiration becomes deep and the pulse is full and rapid. The pupils are dilated, and the face becomes dusky or livid. This stage soon merges into—

The third stage of surgical anæsthesia, which lasts about 30 to 60 seconds. The patient becomes suddenly cyanotic and respiration becomes slightly irregular and noisy. The pulse remains fast. The corneal reflex is lost, and the eyes remain fixed with the pupils dilated. Voluntary muscles are relaxed though individual muscles may show convulsive twitchings. It is the stage, though short, available for doing minor surgical operations requiring very little time, such as the pulling out of teeth or opening an inflamed abscess. The mask is then removed and the patient regains complete consciousness within a few minutes without any bad after-effects.

The anæsthetic effect produced by pure nitrous oxide being very short, it is rarely used as such. It is given mixed with oxygen by the help of a specially designed apparatus, in the proportion of 90 per cent. of nitrous oxide and 10 per cent. of oxygen. This mixture depresses the nervous system without asphyxial symptoms and increases the period of anæsthesia. The dilution of the gas with more oxygen, however, lowers the concentration effect in the blood to the corresponding degree, which interferes with the narcotic action and prevents complete muscular relaxation.

C. CEREBRAL EXHILARANTS

CAFFEINE

Caffeina.—Caffeine. *Synonyms.*—Theine, Guaranine. It is the chief alkaloid of several plants notably, tea, coffee, kola and guarana. In each of these plants, it is associated with theobromine, tanninas, volatile oils, aromatic and other substances. The percentage of it, however, varies to a great extent. Tea leaves contain about 3 to 5 per cent.; coffee about 1·3; guarana, 4·5 and kola 2·5. It is a very feeble alkaloid, its salts being very liable to be split up. It can be prepared synthetically from Xanthine.

It occurs as odourless, white, silky, glistening needles usually matted together in fleecy masses. It is bitter in taste and soluble in 80 parts of water. An addition of ½ gr. of sodium salicylate to each grain of caffeine makes a perfect solution.

Incompatibles.—Potassium Iodide, Salts of mercury and Tannic acid.

Dose—2 to 5 grs.—0·12 to 0·3 G.

Caffeina et Sodii Benzoas.—It is a mixture of Caffeine and Sodium Benzoate and contains about 50 per cent. of each. It occurs as a white odourless powder with a slightly bitter taste. Soluble in 1 part of warm water, a portion of caffeine separating, when the solution is allowed to cool. Completely soluble in 4 parts of water.

Dose—5 to 15 grs.—0·3 to 1 G. by the mouth.
2 to 5 grs.—0·12 to 0·3 G. by injection.

ACTION OF CAFFEINE

External.—None.

Internal.—*Alimentary Tract.*—The action of caffeine on the stomach, if taken in the form of tea or coffee is less important as it is masked by the action of tannin and the aromatics contained in them. The brewing of tea and boiling of coffee for a long time dissolves a large quantity of tannin and their continuous use may cause indigestion by the astringent action of tannin. In the intestines, **tea** owing to the larger percentage of tannin is rather **constipating**; while **coffee** with a larger percentage of oils is said to be **laxative.** Caffeine pure has no action on the intestinal tract as it does not excite peristaltic movement.

Absorption and Elimination.—It is readily absorbed from the stomach and intestines, and circulates in the blood unchanged lowering its osmotic tension as well as its viscosity. A small portion of it is excreted unchanged in the urine and a greater part is reduced in the body and is excreted as urea.

Circulatory System.—Caffeine affects circulation in a complex manner; and this is due to the simultaneous stimulant action it exerts on the medullary centres as well as on the muscle of the heart. In small doses, it stimulates the vagal centre causing a momentary slowing of the heart, but this is soon counteracted by the powerful and quicker systolic contractions induced by the direct action of the drug on the muscles of the heart especially on that part from which contractions originate. This acceleration, however, does not increase the cardiac output for unlike digitalis, the relaxation following the contraction is not prolonged, and there is not therefore sufficient interval for the inflow of blood. The stimulation of the vaso-motor centre causing contraction of the systemic blood vessels may suggest initial rise of blood pressure, but on account of the simultaneous widening of the blood vessels and the coronary arteries through the direct action of the drug on their walls, the blood pressure is not affected. Larger doses of caffeine weaken the heart which beats rapidly and irregularly and causes considerable fall in the blood pressure.

Respiratory System.—At first the stimulation of the respiratory centre increases the number and depth of respiration. There is a marked increase in the alveolar ventilation and the blood is better aerated, but later on the lessened amount of carbonic acid gas in the blood causes the respiration to become shallow, as it is not adequate to stimulate the respiratory organ to produce the full effect. Caffeine exerts an **antispasmodic** effect by causing the dilatation of the bronchi.

Nervous System.—Caffeine acts as a **stimulant** to the central nervous system. In small doses it **selects only the higher psychical centres** for its action. The mental functions are, therefore, exalted. The prompt associations of ideas quicken thought processes and the co-ordinated stimulation of the cerebral centres associated with reason, judgment and will, help the subject to carry out his ideas more efficiently. The special senses are rendered more acute owing to the stimulation of the perceptive centres in the brain. This excited condition of the cerebrum induces a condition of wakefulness. The stimulation of the motor centres helps the subject to put in more physical work than normal, without feeling fatigue ; but large doses of caffeine produce confusion of thought, create subjective sensations, such as flashes of light and ringing noises in the ear, induce physical restlessness and tremors ; and excite reflex activity, which ultimately passes on to convulsions due to the stimulation of the spinal cord.

Caffeine in small doses **stimulates** all the **vital centres** in the medulla.

Voluntary Muscles.—Caffeine has a specific action on the voluntary muscles. In small doses, it increases their irritability and induces contraction even after a weak stimulus or against great resistance. In large doses, the muscles become rigid and pass into a condition of rigor probably due to increase in the ferment which induce postmortem rigidity in the muscles by converting myosinogen into myosin.

Kidneys.—Caffeine is a powerful and reliable **diuretic** and acts best when there is excess of water in the tissues as in œdema. The increase in the quantity of urine is more marked in the watery constituent than in the solids. The diuretic effect is produced by (1) an increased flow of blood through the kidneys, due to the dilatation of the renal vessels and stimulation of the heart ; (2) increased filtration through the glomerular cells, due to the increase in the salt contents of the plasma and (3) diminished reabsorption through the tubules.

Caffeine v /s. other Cerebral Stimulants.—The so called stimulant effect of alcohol is due to the depression of the higher psychic centres which have a controlling influence over the lower motor centres. Cocaine stimulates both the sensory and motor areas and the stimulation is followed by depression. Atropine and camphor stimulate the motor areas. None of these drugs resembles caffeine in producing an unmixed stimulation of the higher centres.

THERAPEUTIC USES

Caffeine is used as a stimulant in the depressed condition of the central nervous system, as in cases of narcotic poisoning. It is used as a stimulant in cases of heart disease. As a diuretic, it is useful in cardiac dropsy. It sometimes relieves headache and neuralgia.

Class II

DRUGS ACTING CHIEFLY ON THE SPINAL CORD-

NUX VOMICA

Nux Vomica. *Synonyms.*—Strychnin Semen ; Poison Nut. The dried ripe seeds of *Strychnos Nux-Vomica*, a tree native to

India. The seeds are ashen-grey, flat, circular with a concave-convex surface, extremely bitter in taste. They contain in their composition an important alkaloid, *Strychnine*, which is official. Powdered Nux-vomica when used for official purposes must contain 1·25 per cent. of strychnine.

1. **Nux-Vomica Pulverata.** *Synonym.*—Pulvis Nucis Vomicæ.

Dose—1 to 4 grs.—0·06 to 0·25 G.

2. **Extractum Nucis Vomicæ Liquidum.**—Alcoholic. Standardised to contain 1·5 per cent. of strychnine.

Dose—1 to 3 ms.—0·06 to 0·2 mils.

3. **Extractum Nucis Vomicæ Siccum.**—Standardised to contain 1·5 per cent. of strychnine.

Dose—¼ to 1 gr.—0·015 to 0·06 G.

4. **Tinctura Nucis Vomicæ.**—Prepared from liquid extract by addition of water and alcohol (90 per cent.). Standardised to contain 0·125 per cent. of strychnine or 1/30 grs in 30 ms.

Dose—10 to 30 ms.—0·6 to 2 mils

Strychninæ Hydrochloridum.—Strychnine Hydrochloride colourless, odourless crystals, almost insoluble in water. Very bitter in taste.

Dose—$\frac{1}{32}$ to $\frac{1}{8}$ gr.—0·002 to 0·003 G.

Incompatibles.—Alkalies, iodides, bromides, tannin, arsenates and arsenites. With iodides and bromides it forms a slow precipitate of bromide and iodide of strychnine.

1. **Liquor Strychninæ Hydrochloridi.**—Contains 1 per cent. of strychnine hydrochloride.

Dose—2 to 8 ms.—0·12 to 0·5 mils.

2. **Syrupus Ferri Phosphatis cum Quinina et Strychnina.** Each fluid drachm represents $\frac{1}{80}$ gr. of strychnine.

Dose—30 to 60 ms.—2 to 4 mils.

ACTION OF STRYCHNINE

External.—Strychnine is a powerful antiseptic but too poisonous to be used on the wounds.

Internal.—*Alimentary Tract.*—Strychnine is a stimulant to the whole of the gastro-intestinal tract. In the stomach, acting as a bitter **stomachic,** it increases the vascularity of the gastric mucous membrane, the secretion of the gastric juice and the movement of the stomach. In the intestines it **stimulates** the **peristaltic movement** and acts as a purgative.

Absorption and Elimination.—Absorption of strychnine differs in different parts of the alimentary canal. It is slowly absorbed from the stomach, but promptly from the mouth, large and small intestines and rectum. It circulates in the blood as such and is stored up mainly in the liver. A part of it escapes to the nervous tissue and the kidneys. It is eliminated only in a small quantity chiefly in the urine. A major portion is either destroyed in the liver or remains fixed in the loose combination. This fact accounts for the difference between the toxic dose by mouth or by injection. Owing to its quick absorption and slow elimination, it is apt to be cumulative in action as the tolerance for the drug is never established.

Circulatory System.—Except in increasing the action of the heart, strychnine has very little action on it in medicinal doses. **The blood pressure** is, however, **raised** by constricting the blood vessels of the splanchnic area due to the stimulation of the vaso-motor centre and also by the increased peripheral resistance depending on the increased tonus of the plain muscles of the arteries and of the voluntary muscles. The rise of blood pressure, however, is not very marked owing to the simultaneous dilatation of the cutaneous vessels due to the stimulation of the vaso-dilator centre. In moderately large doses, the asphyxial stimulation of the vaso-motor centre may cause momentary rise in the blood pressure.

Respiratory System.—The respiratory centre is markedly stimulated by moderate as well as by large doses of strychnine. The respiration becomes **quicker** and **deeper.** In poisonous **doses, the fixation of the respiratory muscles, as an implication** of general convulsions, causes asphyxia, and death occurs by respiratory failure. The heart may continue to beat for sometime after the cessation of respiration.

Nervous System.—In medicinal doses, strychnine exerts an important action on the central nervous system. Every part of the nervous system, without exception, is stimulated, so that it responds even to a weak afferent stimulus. Its most characteristic action, however, is manifested in the **increase of spinal reflexes.** Strychnine, in small doses, increases the sensitiveness of the motor cells in the spinal cord—anterior cornua, and exaggerates the conduction power of the cord, in such a way that a very slight local stimulus is sufficient to produce a spasmodic twitching of the muscle of that part. In moderately large doses this afferent stimulus to a single centre radiates thence to other centres to induce a reflex response from the entire body. In poisonous doses, even an unconscious stimulation is quite enough to send the muscles of the whole body in generalised tetanic convulsions in which the flexors and extensors muscles of the body participate; but as the latter predominate, the limbs are rigidly extended, the head is thrown backwards and the vertebral column is arched with the convexity backwards, the patient remaining in the position of opisthotonos resting on his head and his heels. The contraction of the muscles of the face causes a *risus sardonicus*—a grinning appearance. The muscles after a minute or two relax from the fatigue of the motor cells of the cord to go again through the same cycle in quick successions of convulsive movements. Normally, according to the **law of reciprocal innervation** when a muscle contracts, the action of the opposite muscle is inhibited and it relaxes, making co-ordinated movement possible. According to Sherington, strychnine abolishes this law and makes all inhibitory impulses excitatory, while according to others, this "strychnine reversal" is more apparent than real, and is due to the easy radiation of afferent stimulus to a single motor centre spreading even, to those other motor centres that are ordinarily beyond its influence and thus induces a reflex response from the entire body.

Medullary centres are all **stimulated** in proportion to their dependence on reflexes, and the respiratory centre, being most reflex in its activity, is profoundly affected.

Psychic centres in the brain are but little influenced. The cortical motor centres are stimulated in the same way as in the spinal cord. All special senses are stimulated and rendered more acute. The field of vision, especially for blue, is said to be enlarged and pain stimuli are more plainly perceived.

Small doses, repeatedly administered, are **cumulative** in effect and the danger signal to stop the drug is manifested in painful stiffness of all the muscles, difficulty in swallowing and a constricted feeling in the chest with a sense of anxiety.

Antagonism.—Physostigmine (*Vide infra*) is its true physiological antagonist as it depresses the spinal cord; but in cases of poisoning by strychnine, it is powerless. Chloral hydras and morphine by depressing the brain as a whole and the bromides by depressing the spinal cord act as antidotes in controlling the convulsive activity of strychnine.

THERAPEUTIC USES

There is very little difference, save in the degree of force, between the action of nux-vomica and that of strychnine. Preparations of nux-vomica are generally used when a local action on the stomach and intestine is desired, while the giving of strychnine is restricted to its action on distant organs after absorption. Nux-vomica is, therefore, largely used as a bitter stomachic and a purgative. It is also used as a stimulant tonic in all conditions characterised by the loss of energy. It is, therefore, used in the treatment of alcoholism and in various forms of paralysis. As a respiratory stimulant, it is used in chronic bronchitis, pneumonia, pulmonary tuberculosis and emphysema. It is used in diseases of the heart when digitalis is contra-indicated.

NIKETHAMIDE

Nikethamidum.—Nikethamide. *Synonyms.*—Coramine Anacardone, Nicamide. It is a pale yellow oily liquid or crystalline solid ; odourless ; taste faintly bitter, followed by a sensation of warmth. Miscible with water.

Dose—3 to 8 grs.—0·2 to 0·5 G.

8 to 20 grs.—0·5 to 1·25 G. by intravenous injection as a stimulant.

Injectio Nikethamidi.—It contains in 60 minims about 14 grains of Nikethamide.

Dose—15 to 60 ms.—1 to 4 mils. by subcutaneous injection or intramuscular injection.

75 to 240 ms.—5 to 16 mils. by intravenous injection as convulsant.

LEPTAZOL

Leptazolum. *Synonym.*—Cardiazol. White crystalline powder ; odourless ; taste, slightly pungent, bitter. It is readily soluble in water.

Dose—¾ to 1½ grs.—0·05 to 0·1 G.

Injectio Leptazoli.—It contains 10 per cent. of Leptazol.

Dose—8 to 15 ms.—0·5 to 1 G. by subcutaneous injection.
30 to 75 ms. increasing to **180 ms.**

2 to 5 mils. increasing to **12 mils.** By intravenously as a convulsant.

ACTION AND THERAPEUTIC USES

The most striking effect of Nikethamide and the allied drugs is the stimulation of the respiration with a sustained rise in the blood pressure. The rise of blood pressure is due to stimulation of vaso-motor centres which regulate and co-ordinate the various factors of circulation. They are absorbed from all modes of administration. It is the most effective by intravenous injection. The drugs have a wide margin of safety, the toxic dose being ten times the therapeutic dose.

Nikethamide and Leptazol have been widely used as the respiratory stimulants in poisoning surgical anæsthesia, collapse, alcoholism, etc. It is indicated in circulatory failure of central origin, as in traumatic or surgical shock syncope, etc.

Class III

DRUGS DEPRESSING THE MOTOR NERVE ENDINGS

Curare, Conium, Tobacco.

These drugs, paralysing the motor nerve endings, are not official. They are of no therapeutic value as it is never desirable to paralyse the muscles, the inevitable result of a depressing action of a drug on the motor nerves and their endings. In large doses, these drugs also paralyse the autonomic ganglia as well as the vital centres in the medulla.

Curare, at one time, was used to prevent the convulsions of tetanus, hydrophobia and strychnine poisoning, while conium and tobacco were used as antispasmodic in curing asthma, fits, croup, epilepsy and tetanus. To-day they have been replaced entirely by more certain and less poisonous remedies.

DRUGS DEPRESSING THE SENSORY NERNE ENDINGS

Cocaine and Cocaine Substitutes.

COCAINE

Cocaina.—Cocaine is an alkaloid obtained from the leaves of *Erythroxylon Coca* and its varieties. It occurs as colourless, odourless crystals with a bitter taste, almost insoluble in water, but easily soluble in alcohol, ether and olive oil.

Dose—⅛ to ¼ gr.—0·008 to 0·016 G.

Cocainæ Hydrochloridum.—Cocaine Hydrochloride. Occurs in colourless prisms, very soluble in water.

Dose—⅛ to ¼ gr.—0·008 to 0·016 G.

1. **Lamellæ Cocainæ.**—Contains $\frac{1}{200}$ gr. of Cocaine Hydrochloride.

2. **Oculentum Cocainæ.**—Contains 0·25 per cent. of Cocaine Hydrochloride.

3. **Trochiscus Krameriæ et Cocainæ.**—Each contains 1 gr. of Krameria and $\frac{1}{20}$ gr. of Cocaine Hydrochloride with a fruit base.

ACTION OF COCAINE

External.—Cocaine has no action on the unbroken skin. Injected subcutaneously or applied to raw and mucous surfaces, it exerts a paralysing effect on the terminations of the sensory nerves and induces **local anæsthesia** and at the same time **constricts the blood vessels** by stimulating the vaso-motor nerves. It thus diminishes hæmorrhage, while operating under its local anæsthetising effect. Its topical application to the mucous membrane of the nose, abolishes the sense of smell.

Internal—*Alimentary Tract.*—Applied to the tongue, cocaine abolishes the taste of bitterness, diminishes that of sweetness and keeps unimpaired that of salt. In the stomach, it anæsthetises the gastric mucous membrane, deadens the sensation of hunger without impairing digestion, and acts as an **anti-emetic.** In larger doses, it stimulates the peristaltic movement of the intestines and causes diarrhœa. It may act as an **emetic by central action.**

Absorption and Elimination.—Cocaine is readily absorbed when administered by the subcutaneous injection or when applied to the mucous surfaces. Some hindrance to its absorption is, however, caused by the constriction of the blood vessels by its local action. The addition of a little adrenaline to the solution also lessens its absorption. After absorption it circulates in the blood as such and a portion of it is rapidly excreted by the kidneys ; while a part of it remains in loose chemical combination with the tissues, mostly the nervous tissue. This absorption into the tissues reduces much of its toxicity.

Nervous System.—The chief action of cocaine is on the central nervous system. In moderate doses, it stimulates the whole of the nervous system in its descending order. In larger doses, it depresses the nervous system in the same order. The stimulation of the highest psychic centres in the brain is manifested in the exaltation of the mind, but there is inability on the part of the subject to keep it fixed on any one subject for a long time. He becomes talkative and wakeful, but remains self-possessed. The stimulation of the motor areas in the brain is seen in physical restlessness, increased endurance against fatigue, and increased sensitiveness to stimuli. With larger doses, this effect spreads to the medulla and spinal cord. In poisonous doses, it causes convulsions to supervene.

Circulatory System.—Its effects on circulation are partly central and partly peripheral, and vary according to the dose administered. In small doses, there may be a temporary slowing of the heart due to the stimulation of the vagal centre. In moderately large doses, the heart is accelerated by its direct effect on the muscles of the heart and accelerator nerve endings in it. The stimulation of the vaso-motor centres constricts the systemic blood vessels and causes the blood pressure to rise. In poisonous doses, the heart is paralysed and death may result from cardiac failure.

Respiratory System.—In medicinal doses, the respiratory centre is stimulated to increase the number and depth of respiratory movements. In large doses, the respiratory centre is depressed leading to shallow and laboured breathing of the "Cheyne-Stoke's Type" which when interfered with by convulsions causes asphyxia and death.

Eye.—A solution of cocaine of moderate strength—4 per cent.—when dropped in the eye causes complete anæsthesia of the cornea and conjunctival mucous membrane, constriction of the blood vessels and dilatation of the pupil in about 7 to 10 minutes. The dilatation of the pupil lasts for about 2 or 3 hours. It is due to the stimulation of the sympathetic nerve endings in the iris. The palpebral aperture is widened. Accommodation is partly paralysed and the ocular tension is lowered, but the light reflex is preserved. The dilatation of the pupil is however never maximal, as it could be further dilated by instilling atropine drops in the eye. Though both cocaine and atropine dilate the pupil, yet their mode of action and the associated phenomena differ in many points which are tabulated below :—

	COCAINE MYDRIASIS	ATROPINE MYDRIASIS
1.	It dilates the pupils by stimulating the sympathetic endings in the iris.	Dilates the pupil by paralysing the endings of the oculo-motor nerve in the iris.
2.	Dilatation of the pupil is partial and lasts for a short time.	Dilatation of the pupil is complete and lasts for 3 or 4 days.
3.	The pupils react faintly to light.	Light reflex is completely lost.
4.	The pupils react readily to Pilocarpine.	The pupils resist the action of Pilocarpine.
5.	The intra-ocular tension is lowered.	The intra-ocular tension is raised.

Temperature.—Cocaine, in poisonous doses, stimulates the thermogenic centre and causes increase in the body temperature.

Kidneys.—Cocaine has no direct influence on the kidneys, but may influence the flow of urine by its effect on the calibre of the renal vessels and on the general blood pressure.

Habit and Tolerance.—Cocaine being a powerful stimulant to the nervous system, is generally given or taken, in the form of coca-wine, to dissipate both muscular fatigue and brain fag, or to break the habit of morphine or alcohol. The drug produces pleasurable sensations and day by day one is required to take it in larger doses to induce the very sensations and thus a tolerance for the drug is gradually established. This tolerance in the case of cocaine reaches a definite dose after which no further increase becomes necessary.

Drawbacks of Cocaine.—High toxicity, delayed elimination, habit formation, poor keeping qualities in solution, and its decomposition at boiling temperature, makes cocaine an undesirable local anæsthetic.

Cocainism.—The continued ingestion of cocaine produces symptoms of chronic poisoning known as "Cocainism." The symptoms manifested are :—impairment of digestion, marked and rapid emaciation, insomnia and enfeeblement of intellect. There are hallucinations of sight and feeling. The sensory disturbance is seen in the scratching of body caused by sensation of a vermin creeping on it and is known as "Cocaine Bugs." The face becomes pale and anxious, eyes sunken and have a shifty expression. Later on, the subject becomes acutely maniac with delusions of persecution.

Cocaine v /s. Caffeine.—The effect of Cocaine, like caffeine, is of a real stimulation of the central nervous system. But it differs from caffeine in stimulating the psychic centres less markedly and co-ordinately and in stimulating the motor centres more profoundly than caffeine. In larger doses, both cause convulsions.

THERAPEUTICS

The chief use of cocaine is for producing local anæsthesia in minor surgical operations on the eye, nose, ear, tooth, etc. Cocaine solution is injected into the subdural space of the spinal cord for producing anæsthesia of the body below the site of injection. It is also injected into the body of the nerve for producing regional anæsthesia.

It is given internally to check vomiting and to relieve pain in the stomach. Cocaine ointment is used to diminish the pain and irritability of various forms of skin disease and in corneal affections. Cocaine with Krameria lozenges are useful in irritable sore throat.

Cocaine Substitutes.—Owing to the poisonous effects of cocaine and its habit forming quality, it becomes an undesirable anæsthetic, and many new synthetic anæsthetics have been introduced to replace it. These local anæsthetics, to act as substitutes for cocaine, must not only retain its advantageous features such as its solubility, quick penetration when applied to mucous surfaces, efficiency and power of constricting the blood vessels, but at the same time they must be devoid of its poisonous systemic action and formation of drug habit. All these new anæsthetics have some defect or other. The only substitute, in association with adrenaline, that gives the best approximation to the advantages of cocaine, without its disadvantages, is **Novocaine** (Ethocaine Hydrochloride). (*Vide infra.*) It has been extensively used in all forms of anæsthesia. It is very safe if associated with adrenaline and not injected into a vein. **Stovaine** has still retained its usefulness as a spinal anæsthetic.

ORTHOCAINE

Orthocaina. *Synonyms.*—Methyl-meta-amino-paraoxybenzoate, Orthoform. It occurs as a white or faintly yellow crystalline powder without odour or taste. Almost insoluble in water, but soluble in ether, alcohol and alkali solutions.

Dose—1½ to 3 grs.—0·1 to 0·2 G.

ACTION AND THERAPEUTIC USES

Orthocaine being insoluble in water, is used as a dusting powder and acts as an **antiseptic** and **analgesic.** It has no action on the unbroken skin, but applied to raw or mucous surfaces, it allays the pain of inflammation. It, however, injures partly devitalised tissues and causes sloughing of the parts. Suspended in oil in 10 per cent. solution, it is used in the form of a spray into the nostrils for relief of coryza and for lessening the paroxysms of whooping cough. It is also sprayed into the pharynx and larynx to relieve the pain of tubercular and syphilitic ulcerations. It is given internally to relieve the pain of gastric ulcer or cancer and gastralgia from any cause.

BENZOCAINE

Benzocaina. *Synonym.*—Ethyl Aminobenzoate. Anæsthesin. A white crystalline powder stable in air. It is odourless and has a slightly bitter taste which is followed by a sensation of numbness.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION AND THERAPEUTIC USES

Benzocaine has actions and uses similar to those of orthocaine and is sometimes preferable to it as it is less likely to cause sloughing of the devitalized parts.

PROCAINE HYDROCHLORIDE

Procainæ Hydrochloridum. *Synonyms.*—Ethocaine Hydrochloride; Novocaine. Occurs as colourless crystalline powder. It is odourless and stable in air. It has a slight bitter taste which is followed by a transient insensibility of the tongue.

Dose—½ to 2 grs.—0·03 to 0·12 G. by the mouth.
Up to 15 grs.—1 G. by subcutaneous injection.
„ 2½ grs.—0·15 G. by intrathecal injection.

Injectio Procainæ et Adrenalinæ.—It contains 2 per cent. of Procain Hydrochloride.

ACTION AND THERAPEUTIC USES

Of all the synthetic substitutes of cocaine, procaine hydrochloride, associated with suprarenin, has all the advantages of cocaine without its more serious disadvantages. It is nowadays extensively used for all forms of local anæsthesia—

for application to accessible mucous membranes, for subcutaneous injections for nerve blocking and for intraspinal injections. It acts by paralysing all nerve tissue with which it comes in contact in sufficient concentration, which may vary from 0·1 to 2 per cent. under different circumstances. It is rapidly absorbed into the system when applied to the mucous surfaces or when injected. The portion absorbed is rapidly destroyed in the liver, very little, if any, being excreted ; its rapid destruction explains the non-toxicity of large doses. When given by the mouth, it anæsthetises the mucous membrane of the stomach, and thereby, appetite is lost, nausea is not felt and pain is relieved. Locally **it dilates the blood vessels.** It is not destroyed by boiling, and may be associated with suprarenin without decomposition.

AMYLOCAINE HYDROCHLORIDE

Amylocainæ Hydrochloridum. *Synonym.*—Stovaine. It occurs as a colourless, crystalline powder with a bitter taste, followed by a transient insensibility of the tongue.

Dose—⅓ to ¾ gr.—0·02 to 0·05 G. by the mouth and by subcutaneous injection.

⅓ to 1½ grs.—0·02 to 0·1 G. by intrathecal injection.

ACTION AND THERAPEUTIC USES

Amylocaine Hydrochloride has the same action and uses as procaine hydrochloride and is used for inducing local anæsthesia. It is irritant to the tissues when locally injected and is decomposed by boiling. Its use is largely limited to intraspinal injection.

ACONITE

Aconitum.—Aconite. *Synonyms.*—Aconiti Tuber ; Aconite Radix. The dried root of *Aconitum Napellus.* It is without marked odour or taste, but when chewed it produces a tingling sensation, followed by numbness. Its active

Respiratory System.—The respiratory centre, after a brief period of stimulation, is paralysed even before the cardiac; so after a transitory increase in the respiratory phenomena, it becomes slow, shallow and irregular and death occurs from asphyxia.

Nervous System.—The most noteworthy effect of hydrocyanic acid, after its absorption in a large quantity, on the central nervous system is the paralysation of the subcortical regions of the brain after initial stimulation. **The cardiac, vaso-motor and respiratory centres are all paralysed.** The excitability of the cord is momentarily increased, but later on it is completely abolished. The motor nerves and muscles are also paralysed. In poisonous doses, its paralysing effects on the brain are manifested in insensibility and coma. The pupils are dilated. These effects may be due to the direct action of the drug on the cerebrum or to the altered condition of the blood from asphyxia.

Acute Poisoning.—Large doses of diluted hydrocyanic acid are generally swallowed with the intention of committing suicide. It is regarded to be the most powerful poison on account of the suddenness of its action and the difficulty of resuscitation, rather than by its toxic dose. Death may occur almost immediately, or as is generally the case, within fifteen minutes to an hour. With a large fatal dose, the patient falls unconscious with a loud cry, followed by a few convulsions and death. But in cases where several minutes elapse after taking the poison, the first symptoms are vertigo and headache, followed by dyspnœa and violent respiratory effort; salivation and vomiting may occur. The face is pale and the pulse weak, feeble and sometimes almost imperceptible. Tremors soon develop into general convulsions, which are followed by coma, dilated pupils, protrusion of the eye-ball and death due to failure of respiration. In some cases, the heart-beat lasts a few minutes after the stoppage of respiration.

THERAPEUTIC USES

It is rarely used externally as a therapeutic measure, except as an antipruritic in the form of a lotion when other measures have failed. Internally, diluted hydrocyanic acid is used as a nerve sedative in gastrodynia and nervous dyspepsia, and for the relief of cough. Aqua Laurocerasi, as it contains minute quantities of hydrocyanic acid, forms a good vehicle for cough remedies, but the dose should not exceed ½ to 1 fl. drachm.

DRUGS STIMULATING THE SENSORY NERVE ENDINGS

SKIN-IRRITANTS AND COUNTER-IRRITANTS

ACTION AND THERAPEUTIC USES

The action of vegetable drugs as skin-irritants, is due to a volatile substance in their composition. It may be an oil, a gum or a resin. Skin-irritants, whether organic or inorganic, are applied to the surface of the skin with the object of relieving pain, diminishing congestion, and accelerating the absorption of inflammatory products. They, by the stimulation of the sensory nerve endings, produce reactions of three kinds :—(1) Local vaso-dilatation; (2) reflex stimulation of the medullary centres ; and (3) a special reflex action producing circulatory and trophic changes in the viscera, innervated from the same segment of the spinal cord as the area of the skin irritated.

Local Vaso-dilatation.—The various effects of skin-irritants, depending on the intensity of the drugs and the duration of their application, have already been described on page 99. The burning sensation and the redness of the skin are due to the irritation of the sensory nerve endings and to the reflex stimulation of the vaso-dilator nerves. The latter effect is entirely dependent upon axon reflexes, *i.e.*, reflexes produced without the impulses passing through a nerve cell. It is independent of the central nervous system and is not produced if the portion of the skin to which an irritant is applied is previously anæsthetised.

Reflex stimulation of the medullary centres.—The irritation of the skin produces an effect on the general circulation. The effect, however, varies according to the extent, rapidity, intensity, and the kind of irritant used. Applied for a short time, mild irritants exert only a rubefacient action on the skin and stimulate reflexly the vaso-motor, respiratory and cardiac centres in the medulla with a consequent rise in the blood pressure, increase in the number and depth of the respiratory movement, and acceleration of the heart. When the irritation of the skin is sudden, extensive and intense, there occurs paralysis of the vaso-motor centre with a consequent fall in the blood pressure and sudden inhibition of heart's action as is seen in " Surgical Shock " or after a sudden blow on the abdomen.

Special reflex action.—Certain skin-irritants, particularly those which do not destroy the dermis, are applied to the skin, exclusively for curing morbid processes in the deep-seated organs and tissues. The researches of Head and Makenzie have shown that there are certain areas of the skin which are connected with the viscera underneath, and any morbid process in the viscus, such as inflammation or disordered function, sends a powerful impulse to the spinal cord and stimulates reflexly either the motor or sensory centres in it. The stimulation of the motor centre is manifested in the rigidity of the muscles, as a protective measure, over the inflamed tissue. The stimulation of the sensory centres results in a sensation of pain, which is referred to the skin area supplied by the same spinal nerve as supplied to the organ. This is called the " Viscero-sensory " reflex. To relieve these conditions, an irritant is used as a **counter-irritant** over the areas of referred pain and hyperæsthesia with the object of starting an afferent impulse. It is transmitted in the reverse direction through the spinal centres to the organ so as to modify the morbid processes by influencing the trophic and vaso-motor nerves.

The mitigation of the referred pain by counter-irritation is probably a psychic phenomena, and is masked by the pain of irritation which stimulates the perceptive area of the brain to perceive the new pain is the exclusion of all others.

CANTHARIDIN

Cantharidinum.—It is the anhydride of Cantharidic Acid, obtained from the species of *Cantharis* (Spanish Fly) or of *Mylabris*; both beetles. It occurs in colourless shining crystals very slightly soluble in water, but most soluble in fixed oils and chloroform.

Emplastrum Cantharidini.—Contains 0·2 per cent. of Cantharidin.

Liquor Epispasticus. *Synonym.*—Blistering Liquid contains 0·4 per cent. of Cantharidin.

ACTION OF CANTHARIDIN

Externally.—Cantharidin is extremely irritating to all the tissues with which it comes in contact. Applied to the skin, it induces within an hour, redness, numbness and a tingling and burning sensation, which is later on followed by small vesicles; these coalesce together to form a blister. Cantharidin thus acts as a **rubefacient, a vesicant,** and at the same time a **counter-irritant** modifying the circulation and functions of internal organs in a reflex way.

Internal.—*Alimentary Tract.*—It in moderate doses is a gastro-intestinal irritant producing abdominal pain, diarrhœa and vomiting.

Absorption and Elimination.—Cantharidin is absorbed from the unbroken skin and all mucous membranes. It circulates unchanged and is excreted chiefly by the kidneys. A part of it is also excreted by the gastro-intestinal tract.

Kidneys.—Cantharidin in small doses, during its excretion through the kidneys, stimulates the kidney cells to activity and acts as a **diuretic.** In moderately large doses, it irritates the kidneys and the urinary tract, the irritation being manifested by pain in the loins and strangury. The quantity of urine is diminished, and it may contain albumen and blood. It excites **sexual functions.** There is violent priapism partly by direct, but mostly by reflex, action. In women, cantharidin may cause abortion or induce menstrual flow.

THERAPEUTIC USES

Cantharidin is used solely as a counter-irritant in the inflammatory conditions of the lungs, pleura, pericardium, joints, nerves, etc. It raises a blister over the part of the skin to which it is applied. If the blister is small, as a rule it is not opened, but the exuded serum is allowed to be reabsorbed. If, however, the blister be large, it is better to snip the lower edge and allow the fluid to drain in order to prevent the reabsorption of cantharidin in dangerous amount. Tincture of Cantharidin, largely diluted, is occasionally employed as an ingredient of hair lotions to stimulate the growth of hair and for the cure of ringworm of the scalp.

Cantharidin plasters should be avoided in pronounced renal affections, and should be used with great caution in children, in aged or debilitated persons.

GROUP II

DRUGS ACTING CHIEFLY ON THE AUTONOMIC NERVOUS SYSTEM

These drugs are used for their action chiefly on the involuntary muscles such as of the eye, the uterus, the bronchi and the bowels and on the secretory glands such as salivary, sweat and mucous glands of the bronchi.

The chief of these drugs may be classified as under, and in order to make the classification complete, some of the substances from the animal and inorganic kingdoms will be included in it, but they will be found described in their respective kingdoms.

Class I.—Drugs acting chiefly on the Parasympathetic Nerve Endings.—

A. Stimulants.—Pilocarpine, Physostigmine, Carbachol.

B. Depressants.—Belladonna, Hyoscyamus, Stramonium.

Class II.—Drugs acting on the Sympathetic Nerve Endings.—

A. Stimulants.—Adrenaline, Ephedrine, Ergot in small doses.

B. Depressants.—Ergot in large doses.

DRUGS STIMULATING THE PARASYMPATHETIC NERVE ENDINGS

PILOCARPINE

Pilocarpine Nitras.—Pilocarpine Nitrate. It is a nitrate of an alkaloid obtained from the leaves of *Pilocarpus microphyllus* and other species of *Pilocarpus*. Jaborandi leaves. It occurs in colourless faintly bitter crystals, freely soluble in water.

Dose $\frac{1}{5}$ **gr.—0·01 G.** by the mouth.

$\frac{1}{20}$ to $\frac{1}{5}$ **gr.—0·003 to 0·012 G.** hypodermically.

ACTION OF PILOCARPINE

External.—None.

Internal.—In therapeutic doses pilocarpine nitrate exerts its chief action on the autonomic nervous system and stimulates the parasympathetic nerve endings, to increase the secretions of glands and to excite the movement of the involuntary muscles. Pilocarpine produces these effects even after the nerves have degenerated or cut. It is therefore presumed, by the exclusion of all other factors concerned in the causation of increased secretion, that the drug acts either on the receptive substance interpolated between the nerve endings and the gland cells and the myoneural of junctions the involuntary muscles. According to *chemical theory of action* the stimulation of parasympathetic nerves liberates in the nerve-endings the hormones acetylcholine which acts directly on the cells without the aid of nervous energy. Pilocarpine in its action resembles acetycholine. But the hormone is rapidly hydrolysed to relatively inert substances—acetic acid and choline—by an enzyme, choline esterase, located in the tissues and in the blood. The stimulation of nerve-endings by pilocarpine probably reunites the parts that have been hydrolysed and forms a compound which is more stable than acetycholine and acts directly on the cells. Atropine antagonizes this action by depressing the parasympathetic nerve-endings and making the cells immune to the action of acetycholine or compound formed with choline and thus prevents the effects of parasympathetic stimulation.

It, therefore, stimulates the secretion of the glands of the stomach, intestines, skin, bronchial mucous membrane, nose and ear, and of the lachrymal glands and pancreas. The secretion of bile, milk and urine is not augmented. It also stimulates the involuntary muscular fibres of the iris, gastro-intestinal tract, bronchial tubes, uterus, spleen, heart, bladder, and the muscular coat of the arteries.

Its action on the central nervous system is weak and is entirely overshadowed by its peripheral action.

Alimentary Tract.—The most striking effect of pilocarpine is the **increased secretion of saliva** obtained by the stimulation of the receptor of chorda tympani nerve and other receptor in the salivary glands. It also increases the secretions of gastric and pancreatic juice, but it does not affect the secretion of bile. In moderate doses, it stimulates the endings of the vagus nerve to increase the movements of the gastro-intestinal tract and may lead to nausea, colic and diarrhœa. In larger doses, it causes nausea and vomiting by central action.

Absorption and Elimination.—It is readily absorbed into the blood and is excreted mostly in the urine partly unchanged and partly in a modified form.

Blood.—Owing to the increased secretions of the body, the blood becomes thicker with a consequent increase in the solids of the plasma and red blood cells. The lymphocytes in the blood are also increased due probably to the stimulation of the smooth muscle of the spleen squeezing out the cells.

Circulatory System.—Pilocarpine acts as a cardiac depressant. There is at first transitory acceleration of the heart due to the stimulation of its sympathetic endings but later on **the heart is slowed** by stimulating the vagal endings in the heart and by depressing the muscle of the heart. Thus, after a preliminary rise there occurs a fall in the blood pressure. Pilocarpine dilates all superficial blood vessels but constricts the blood vessels of the splanchnic area. Pulmonary blood vessels are said to be uninfluenced by it.

Respiratory System.—In medicinal doses, the respiratory centre remains unaffected. In larger doses, it is depressed secondarily to the circulatory failure. The bronchial secretion is increased and the bronchioles are constricted by the contraction of the muscles whereby the condition of asphyxia is produced which results in death.

Cutaneous System.—Next to salivation, another striking effect of pilocarpine is the increased perspiration which it induces. It first occurs on the face, extends downwards, and lasts from 3 to 5 hours. The sweating is said to be so profused that as much as a gallon of water may be drained away from the body if the person is kept warm. In the sweat, large quantities of urea and chlorides are eliminated. There is a rise of temperature before sweating, but it falls considerably while it lasts. The secretion of the sebaceous glands is also said to be increased, promoting the nutrition of the hair which grows rapidly and becomes coarser and darker in colour under its influence.

Urinary System.—Pilocarpine has no direct effect on the kidneys. The quantity of urine, however, may get diminished by profuse sweating. Large doses cause sugar to appear in urine and help diuresis. There may be spasmodic contraction of the bladder wall producing constant desire to micturate.

Uterus.—The stimulation of the muscular fibres of the uterus may cause abortion.

Eye.—When applied locally to the eye or given internally in moderately large doses, it **contracts the pupil to a pin-point** by stimulating the receptor of the oculo-motor nerve. **Accommodation of the eye remains fixed to a near point** by stimulation of the ciliary nerves. Intra-ocular tension is diminished owing to the opening of the lymphatic outlets when the pupil contracts. The secretion of tears is also increased.

THERAPEUTIC USES

Pilocarpine is used particularly in kidney diseases with scanty urine to eliminate poisonous substances like urea from the blood. It is also used in suppression of urine and general œdema of the body in order to rest the kidneys. It should be used with caution when the heart is weak. In small doses, it may relieve bronchial catarrh, asthma, and whooping cough, by increasing the bronchial secretion. It is said to be of service in the middle ear disease and tinnitus aurium. Externally, it is used in ophthalmic practice to contract the pupil, and as an ointment to stimulate the growth of hair.

PHYSOSTIGMINE

Physostigminæ Salicylas. *Synonym.*—Eserine Salicylate. It is a salicylate of an alkaloid obtained from calabar bean, the dried ripe seeds of *physostigma venenosum.* It occurs in minute white or faintly yellow crystals, becoming reddish on exposure to air and light ; very deliquescent and readily soluble in water.

Dose—$\frac{1}{100}$ to $\frac{1}{50}$ **gr.—0·006 to 0·0012 G.** Best given subcutaneously.

1. **Lamella Physostigminæ.**—Each contains 1/1000 grain of physostigmine salicylate.

2. **Oculentum Physostigminæ.**—Contains 0·125 per cent. of physostigmine salicylate.

ACTION OF PHYSOSTIGMINE

External.—None.

Internal.—The action of physostigmine is somewhat similar to that of pilocarpine. Like pilocarpine it acts chiefly on the parasympathetic portion of the autonomic nervous system and excites the functions of the involuntary muscles of almost all organs and of the secretory nerves. It, however, differs from pilocarpine in the following points:—(1) In therapeutic doses the effects of physostigmine are more marked on the involuntary muscles than on the secretory nerves. (2) It acts directly on the nerve endings, and not on the receptor substances like pilocarpine. Agreeably to chemical theory of action physostigmine inhibits the hydrolysis of acetylcholine which acts as a direct stimulant to the cells. (3) In moderate doses it involves the nerve centres of the brain, spinal cord and the nerve endings of skeletal muscles. This is rarely seen in pilocarpine unless given in poisonous doses.

Alimentary Tract.—Physostigmine is readily absorbed from the stomach and increases the movements of the gastro-intestinal canal by stimulating the vagus endings. In larger doses, tetanic contractions of the gut lead to colic and diarrhœa. The secretion of saliva in the mouth is increased by the stimulation of nerve endings in the glands ; but it is soon decreased owing to the restriction of the flow of blood in the gland caused by the constriction of the blood vessels.

Absorption and Elimination.—Physostigmine is absorbed from the mucous membrane of the gastro-intestinal tract.

It circulates in the blood unchanged without materially affecting its elements. It is excreted in the bile, saliva and urine.

Circulatory System.—Physostigmine, by stimulating the terminal ends of the vagus and by its direct action on the muscle increases the contractile power and causes the heart to be slower and forcible. In large doses, the heart is paralysed. The blood pressure rises to a considerable point. This is the combined effect of the stimulation of the vaso-motor centre, the contraction of the arteries, and the stimulation of the involuntary muscles of the abdominal viscera, which draws the blood out of the abdomen to the periphery.

Respiratory System.—The respiratory centre after a brief reflex stimulation, depending on the stimulation of the vagus endings in the lungs, is depressed and the breathing becomes slow, shallow and laboured. The dyspnœa is further increased by the constriction of the bronchi preventing ingress of air to the alveoli and as a result asphyxia is produced, which ends in death.

Central Nervous System.—In moderate doses, it depresses the central nervous system with the peculiarity that the depression starts in the lower centres of the cord and spreads upwards. The motor centres in the cord are, therefore, depressed earlier to cause muscular weakness and loss of reflex action. There may be, however, initial increase in the irritability of the cord. The brain remains free from the toxic effects of the drug up to the very last and consciousness remains uninfluenced.

Medullary centres are stimulated and then depressed. In poisonous doses the nerve endings in the voluntary muscles are stimulated to cause tremors and involuntary twitching of the skeletal muscles. The sensory nerves remain unaffected.

Eye.—Applied locally to the eye or given internally, there is contraction of the pupil, spasm of the ciliary muscle causing disturbance of accommodation and the lowering of the intraocular tension. These effects are similar to the effects of pilocarpine on the eye ; but they are produced more slowly than pilocarpine and last longer.

Antagonism.—Its action on the eye and on secretion, on the heart and respiration is antagonistic to atropine. Its action on the cord and respiratory centre is antagonistic to strychnine.

THERAPEUTIC USES

Physostigmine is used chiefly for its effects on the eye. It is used as a myotic to overcome the effects of atropine on the pupil and on accommodation. As a motor paralyser it is used in tetanus. It has been employed to stimulate the bowel and bladder in the atony which follows after abdominal operations and labour. It proves a useful remedy in chronic constipation and tympanites, especially when given in conjunction with nux-vomica and belladonna.

CARBACHOL

Carbachlolum. *Synonyms.*—Doryl, Choryl. It is carbamyl-choline chloride. It was introduced as a substitute for acetylcholine. It occurs as a crystalline powder, markedly hygroscopic in moist air. It is very soluble in water.

Dose—$\frac{1}{64}$ **to** $\frac{1}{16}$ **gr.—0·001 to 0·004 G.**

$\frac{1}{240}$ **to** $\frac{1}{120}$ **gr.—0·00025 to 0·0005 G.** by subcutaneous injections.

ACTION AND THERAPEUTIC USES

Carbachol is powerful parasympathetic stimulator and differs from acetylcholine by being more stable in the body fluids and has prolonged action. It slows the heart ; **it dilates peripheral vessels through direct action on them and there is a marked fall in blood pressure.** There is increased movement and tone of involuntary muscles and profuse secretion from gland.

It is used in urinary retention when not due to obstruction. It has also been to lower blood pressure, tympanites, Raynaud's disease, and glaucoma.

DRUGS DEPRESSING THE PARASYMPATHETIC NERVE ENDINGS

BELLADONNA

Belladonna Folia.—Belladonna Leaves. The leaves and tops of *Atropa Belladonna*, or Atropa lutescens (Indian Belladonna). They are broadly ovate acute leaves yielding not less than 0·3 per cent. of the alkaloids calculated as *hyoscyamine.*

1. **Belladonna Pulverata.** *Synonym.*—Pulvis Belladonnæ. Powdered Belladonna Leaf. 3 grains contain about $\frac{1}{100}$ gr. of total alkaloids, calculated as hyoscyamine.

Dose—$\frac{1}{2}$ to 3 grs.—0·03 to 0·2 G.

2. **Extractum Belladonna Siccum.** Dry extract of Belladonna standardised to contain 1 per cent. of total alkaloids.

Dose—$\frac{1}{4}$ to 1 gr.—0·015 to 0·06 G.

3. **Tinctura Belladonnæ.**—Standardised to contain 0·03 per cent. of the total alkaloids. 30 minims contain $\frac{1}{100}$ grain of the total alkaloids.

Dose—5 to 30 ms.—0·3 to 2 mils.

Belladonna Radix.—The dried root of *Atropa Belladonna* or Atropa lutescens (Indian Belladonna) yielding not less than 0·4 per cent. of the total alkaloids calculated as *hyoscyamine.*

1. **Emplastrum Belladonnæ.**—Prepared from the liquid extract of belladonna root. Contains approximately 0·25 per cent. of the alkaloids of the belladonna root.

2. **Extractum Belladonnæ Liquidum.**—Standardised to contain 0·75 per cent. of the alkaloids of belladonna root. 1 minim contains $\frac{1}{150}$ grain of the total alkaloids.

Dose—$\frac{1}{4}$ to 1 m.—0·015 to 0·06 mil.

3. **Linimentum Belladonnæ.**—Standardised to contain 0·375 per cent. of the total alkaloids of belladonna root, and 5 per cent. of camphor.

4. **Suppositorium Belladonnæ.**—Each contains 0·001 G (about $\frac{1}{60}$ gr.) of the alkaloids.

Atropina.—Atropine. *Synonym.*—Atropia. It is an alkaloid obtained from *Atropa Belladonna* and other plants of the Solanaceæ order. It is really hyoscyamine changing with the maturity of the plant into atropine. It is a mixture of leavohyoscyamine and dextrohyoscyamine in equal proportions. It occurs in white, acicular crystals sparingly soluble in water.

Incompatibles.—Alkalies, soluble salts of heavy metals and tannin.

Dose—$\frac{1}{240}$ **to** $\frac{1}{60}$ **gr.—0·00025 to 0·001 G.**

Atropinæ Sulphas.—Atropine Sulphate. Occurs as a white crystalline 'powder readily soluble in water.

Dose—$\frac{1}{240}$ **to** $\frac{1}{60}$ **gr.—0·00025 to 0·001 G.**

1. **Lamella Atropinæ.**—Each contains $\frac{1}{5000}$ gr. of atropine sulphate.

2. **Oculentum Atropinæ.**—Contains 0·25 per cent. of atropine sulphate.

3. **Oculentum Atropinæ cum Hydrargyri Oxido.**—Contains 0·125 per cent. atropine sulphate and 0·1 per cent. of yellow mercuric oxide.

ACTION OF BELLADONNA

The physiological action of belladonna which are due to its alkaloid atropine are as follows :—

External.—Alone or in a watery solution, belladonna or atropine is not absorbed by the unbroken skin ; but when combined with substances, which are easily absorbed through the skin, it gets into the skin with them. It is quickly absorbed by raw and exposed mucous surfaces and may produce severe poisoning by external application. Local application of belladonna causes vaso-dilatation and depresses the sensory nerve endings. These effects alleviate pain. It, therefore, acts as a **local anodyne.** It is not a true anæsthetic as the normal sensation of the skin remains unaffected.

Internal.—Atropine is quickly absorbed from the mucous membrane of the stomach and intestine, and circulates in the blood as such without producing any effect there. It is excreted unchanged in the urine. Some is excreted in the milk. A small portion of it is oxidised in the body.

After absorption it exerts its chief action on the nervous system, and through it affects other organs and tissues. Its effects on the central nervous system are seen in the stimulation of the cerebral and medullary centres, and on the autonomic system in the paralysis of the nerve endings of the involuntary muscles and of the secretory glands. This peripheral action is brought about either by paralysing the " receptor " susbstance between the nerves and muscles or glands, or by antagonising the action of parasympathetic hormone acetylcholine. In therapeutic doses, it is the latter effect which is more pronounced, and will be described first.

Secretory Nerves.—Atropine in small doses depresses the terminations of all secretory nerves, so that the secretions of those glands, whose activity is dependent on their nerve supply, is markedly diminished, while the secretions of other glands remain unaffected.

The secretion of the submaxillary gland is checked by its paralysing action on the terminations of the secretory fibres of the chorda tympani nerve ; so also of the other salivary and mucous glands by paralysing the endings of the secretory nerves there. Atropine therefore acts as a powerful **antisialagogue.**

The secretion of the stomach and intestines is also diminished from the paralysis of the secretory receptor of the vagus. The secretion of the pancreas is dependent on a hormone and is probably not influenced by atropine. The secretion of bile is not affected.

The secretion of the nose, throat and bronchi is also diminished from the paralysis of their secretory receptor of the secretory nerves. Atropine has no influence on the secretion of the mammary glands as these have no secretory nerves; nor does it materially affect the secretion of the kidneys.

Involuntary Muscles and their Nerves.—Belladonna or Atropine, exercises a marked influence on the involuntary muscles of the stomach and the intestines. It acts as a **sedative** to them, not by inhibiting their peristaltic action but by regulating their spasmodic activity by directly depressing the vagal receptor. Atropine also relaxes the spasm of the involuntary muscle of the bladder, ureter, urethra, uterus, etc., in a similar manner. In large doses, atropine increases peristalsis and causes the relaxation of the bowels by stimulation of the Auerbach's Plexus.

Eye.—When locally applied or given internally by mouth, atropine produces four effects on the eye: It **dilates the pupil, paralyses accommodation** (adaptation of the eye to vision at different distances), **increases intra-ocular tension,** and **causes protrusion of the eye ball.** The dilatation of the pupil is due to the paralysis of the parasympathetic endings of the third nerve supplying the circular fibres of the iris. These being paralysed the radiating fibres of the iris under the influence of the sympathetic, contract to widen the aperture of the pupil. It has no direct action on the iris muscle as it could be made to contract by direct electric stimulation. Very large doses, however, paralyse the iris muscle as they do other muscles. The ciliary muscle, which accommodates the lens by changing its shape, is paralysed in a manner similar to iris. The increase of the intra-ocular tension is an indirect effect depending on the contraction of the iris which closes the spaces of Fontana to prevent the exchange of fluids in the eye. The protrusion of the eye ball is probably the result of increased tension. Its exact mechanism is not known.

Central Nervous System.—In medicinal doses belladonna or atropine has scarcely any effect on the brain. Large doses stimulate and then depress the functions of the brain. In moderately large doses, it excites the central motor area of the brain causing sleeplessness, restlessness and mental excitement passing, with poisonous doses, into delirium, convulsions, stupor and coma—effects similar to the poisonous doses of opium. Larger doses of atropine, therefore, aid the action of poisonous doses of opium and are inadvisable in cases of poisoning by opium.

Medullary centres are stimulated in medicinal doses and depressed by large ones. The respiratory centre is powerfully stimulated. The cardiac and vaso-motor centres are for a time stimulated. The reflex excitability of the spinal cord is slightly increased and then diminished.

Respiratory System.—The stimulation of the respiratory centre by atropine increases the rate and depth of respiration. Large doses paralyse it and breathing becomes slow and shallow, which eventually causes asphyxia and death. The pulmonary vagal endings, both afferent and efferent, are paralysed. There is **relaxation of the bronchial tubes** with diminished sensibility, which relieves reflex cough and dyspnœa. Belladonna therefore acts as an **antispasmodic.** The bronchial secretion is also diminished.

Circulatory System.—Atropine, in very small doses, stimulates the cardiac centre in the medulla and causes the pulse to become slow. With full doses, however, the **vaga endings are paralysed, causing acceleration of the heart,** with consequent quickening of the pulse, without diminishing their force. This is accounted for by the direct action of the drug on the heart muscle. The acceleration of the heart is not so marked at an age when the vagal system is undeveloped as in infants, or at an age when the vagal tone is diminished as in old age. **The blood pressure rises** from the increased rapidity of the heart, and also from the constriction of the blood vessels of the splanchnic area due to the stimulation of the vaso-motor centre. In large doses the blood vessels of the skin dilate, especially of the head and neck, causing flushing and may cause rash to appear on the face. The effects of dilatation of the blood vessels of the other parts of the body are, however, not pronounced, as they are counter-balanced by the constriction of the blood vessels of the abdominal viscera.

Temperature.—Toxic doses of belladonna raise the temperature of the body by 3 to 7 degrees. This is probably due to the direct action of the drug on the thermogenic centre. This rise of temperature leads to the dilatation of the vessels of the skin to lower the temperature by increasing the heat loss.

Idiosyncrasy and Tolerance.—Certain people are very susceptible to the action of atropine. The susceptibility sometimes runs in families. Even in medicinal doses, it produces in them mild delirium or a feeling of thirst and feverishness. In some the idiosyncrasy is manifested by the appearance of rash on the body. The local application of the drug causes inflammation about the eyelids. Children tolerate larger doses of belladonna than those proportionate to their age. Old people bear it badly.

Antagonism.—Physostigmine and Pilocarpine are antagonists to atropine on its action on the autonomic nervous system ; and Chloral hydrate, on its action on the central nervous system. Morphine opposes its effects on the autonomic nervous system by its central action, while it exerts a real antagonistic effect in opposing the stimulant action of Belladonna on the cerebral convolutions, respiratory centre and intestines.

THERAPEUTIC USES

Locally Belladonna is often applied in the form of liniment or plaster to soothe pain in neuralgia, soreness of muscle, acute gout or rheumatism. In the form of suppository, it is used in painful hæmorrhoids. Atropine sulphate in solution is instilled in the eye to paralyse accommodation and to dilate the pupil as an aid to ocular examination or to prevent adhesions in iritis. It is associated with purgatives to prevent intestinal cramps. It is largely used as an antispasmodic in asthma, renal and biliary colic and in dysmenorrhœa, to influence the heart in chloroform poisoning and as a stimulant to the respiratory centre in opium poisoning. It is used in checking the night sweats of phthisis. Belladonna is one of the favourite remedies for the nocturnal incontinence of children.

Homatropinæ Hydrobromidum.—Homatropine Hydrobromide. It is the hydrobromide of an alkaloid synthetically prepared from tropine and mandelic acid. It occurs as a white crystalline powder soluble in 6 parts of water.

Dose— $\frac{1}{64}$ to $\frac{1}{32}$ gr.—0·001 to 0·002 G.

Lamella Homatropinæ.—Contains $\frac{1}{100}$ gr. of Homatropine Hydrobromide.

ACTION AND THERAPEUTIC USES

Homatropine has very nearly the same action as that of atropine. It is, however, used only in ophthalmic practice **to dilate the pupil and paralyse the accommodation.** Its action is more prompt and much more transient than atropine. In some cases, complete relaxation of the ciliary muscle cannot be obtained, probably to its not acting on the nerve endings but on the muscle direct.

STRAMONIUM

Stramonium. *Synonym.*—Stramonii Folia. Dried leaves and flowering tops of *Datura Stramonium.* Contains about 0·25 per cent. of the alkaloids of stramonium calculated as *hyoscyamine.* 3 grains contain about $\frac{1}{120}$ grain of the total alkaloids.

Dose—½ to 3 grs.—0·03 to 0·2 G.

1. Extractum Stramonii Liquidum.—It is an alcoholic extract containing 0·25 per cent. of total alkaloids calculated as hyoscyamine. 3 minims contain about 1/120 grain of the alkaloids of stramonium.

Dose—½ to 8 ms.—0·03 to 0·2 mils

2. Extractum Stramonii Siccum.—It contains 1 per cent. of the total alkaloids. 8 grains contain about $\frac{2}{25}$ grain of the alkaloids of stramonium.

Dose—¼ to 1 gr.—0·0015 to 0·06 G.

1 to 8 grs.—0·06 to 0·5 G. In post encephalitic condition.

3. Tinctura Stramonii.—Contains 0·025 per cent. of the alkaloids of stramonium calculated as hyoscyamine.

Dose—5 to 30 ms.—0·3 to 2 mils.

ACTION AND THERAPEUTIC USES

The action of stramonium is the same as Belladonna, but it actively paralyses the terminations of the vagus in the bronchi and acts as a powerful **relaxant of the bronchial muscles.** It is therefore mainly used in spasmodic affections of the respiratory organs. For this purpose the leaves are often used in the inhalation treatment of asthma in combination with potassium nitrate, which aids their action and maintains a slow combustion.

HYOSCYAMUS

Hyoscyamus. *Synonyms.*—Hyoscyami Folia, Hyoscyamus leaves, Henbane Leaves. The dried leaves and tops of *Hyoscyamus Niger,* yielding not less than 0·05 of the total alkaloids calculated as *hyoscyamine.* Its chief alkaloids are *Hyoscyamine* and *Hyoscine.*

Dose—3 to 6 grs.—0·2 to 0·4 G.

1. **Extractum Hyoscyami Siccum.** *Synonym.*—**Extractum** Hyoscyami. An alcoholic extract standardised to contain 0·3% of the total alkaloids, 1 grain contains $\frac{1}{350}$ grain of the total alkaloids.

Dose—¼ to 1 gr.—0·016 to 0·06 mil.

2. **Extractum Hyoscyami Liquidum.**—Standardised to contain 0·5 per cent. of the total alkaloids. 6 ms. contain about $\frac{1}{370}$ gr. of the total alkaloids.

Dose—3 to 6 ms.—0·2 to 0·04 mil.

3. **Tinctura Hyoscyami.**—Standardised to contain 0·005 per cent. of the total alkaloids. 60 minims contain $\frac{1}{370}$ gr. of the total alkaloids.

Dose—30 to 60 ms.—2 to 4 mils.

4. **Pillula Colocynthidis et Hyoscyami.**—The object of the combination is to regulate the spasm and assist the aperient action of colocynth.

Dose—4 to 8 grs.—0·25 to 0·5 G.

Hyoscinæ Hydrobromidum.—Hyoscine Hydrobromide. *Synonym.*—Scopolamine Hydrobromide. The Hydrobromide of an alkaloid obtained from the plants belonging to *Solanaceæ* order. Occurs as a deliquescent crystalline powder very soluble in water.

Dose— $\frac{1}{200}$ **to** $\frac{1}{100}$ **gr.—0·0003 to 0·0006 G.** Usually given subcutaneously.

Oculentum Hyoscinæ.—Contains 0·125 per cent. of hyoscine hydrobromide.

ACTION OF HYOSCYAMUS

The physiological action of hyoscyamus closely agrees with the action of Belladonna or Stramonium; but as it contains alkaloids having the opposite action on the central nervous system, it differs from them in some important effects. (1) Hyoscyamus has greater **pacifying and hypnotic power** than either of the others due to hyoscine which has a marked sedative action on the brain and spinal cord. (2) It has very little influence on the circulatory or respiratory systems. The acceleration of the heart, which is so marked a phenomena with a moderate dose of belladonna, is absent with a corresponding dose of hyoscyamus. (3) It relaxes the muscular coat of the intestine and increases peristaltic action more powerfully than belladonna; it is therefore a better carminative than belladonna. (4) Its remote local action on the parasympathetic nerve endings, though transient, is more marked and acts as a powerful sedative to the urinary organs. (5) It does not affect intra-ocular tension so much as belladonna.

Hyoscine Hydrobromide resembles atropine in its action on the parasympathetic nerve endings. It differs from atropine, however, in its action on the central nervous system which it depresses from the start without the previous stimulation that is seen with atropine, and it produces sleep without motor excitability. Its advantages over Morphine are that it quiets the reflexes and does not form habit; and Choral Hydrate, that it does not depress the medullary centres.

THERAPEUTIC USES

Hyoscyamus is used in the treatment of urinary diseases, especially in the irritation of the bladder. It is also used in asthma and whooping cough and other spasmodic affections. Combined with purgatives, it is given in constipation and colic. Hyoscine is employed as a sedative and hypnotic in acute mania, delirium tremens, and other conditions associated with mental excitement and sleeplessness. In combination with morphine, it is employed to produce "twilight sleep" preliminary to minor operations and to subdue the pains of labour.

DRUGS STIMULATING THE SYMPATHETIC NERVE ENDINGS.

Ephedrine, Adrenaline and Ergot.

Of the three drugs the first two act prominently on the arteries and the last one has a specific action on the uterus. These drugs are therefore described in their respective groups.

GROUP III

DRUGS ACTING MAINLY ON THE HEART

Class I.—Cardiac Tonics.—Digitalis, Strophanthus, and Squill.

Class II.—Cardiac Depressants.—Aconite.

Class I

CARDIAC TONICS

DIGITALIS FOLIUM

Digitalis Folia.—Digitalis Leaves. *Synonym.*—Digitalis; Foxglove leaves. The dried leaves of *Digitalis purpurea*, collected when the plant is beginning to flower. The leaves have a faint odour and bitter taste. The powder is dark green. The active constituents of the leaves are a number of glucosides, some of them are of uncertain composition. Two crystalline glucosides, *digitoxin* and *gitoxin*. have been isolated in pure form. They are compounds of certain non-carbohydrate constituents called "genins" or "aglucones" with the sugar body, digitoxose. *Digitoxin*, which most nearly represents the digitalis action, hydrolyses into digitoxigenin and digitoxose, while *gitoxin* splits into gitoxigenin and digitoxose. Both these glucosides are insoluble in water, but soluble in chloroform. In addition to these active principles, digitalis contains *digitonin*, a saponin body which possesses the property of holding the active principles in solution in water, as in the infusion. Other constituents of the plants are tannin, volatile oils, starch, sugar, gum, salts, colouring matter, etc. Digitalis contains no alkaloid.

Incompatibles.—The soluble salts of iron and lead, cinchona, strong acids and alkalies destroy the active principles. The glucosides of Digitalis in watery preparations are decomposed by keeping, into resin-like bodies which are toxic. They are also easily destroyed by intestinal ferments.

1. Digitalis Pulverata.—Powdered Digitalis leaves.

Dose—½ to 1½ grs.—0·03 to 0·1 G. for repeated administration.

3 to 10 grs.—0·2 to 0·6 G. for single administration.

2. Infusum Digitalis Recens. *Synonym.*—Infusum Digitalis : 0·05 per cent. in boiling water. Must be freshly prepared.

Dose—90 to 360 ms.—6 to 20 mils. for repeated administration.

1 to 4 fl. ozs.—30 to 120 mils. for single administration.

3. Tinctura Digitalis.—10 per cent. of the drug in alcohol (70 per cent.)

Dose—5 to 15 ms.—0·3 to 1 mil. for repeated administration.

30 to 90 ms.—2 to 6 mils. for single administration.

Digoxinum.—Digoxin is a crystalline glucoside obtained from the leaves of Digitalis Lanta. It occurs in tabular crystals, with a bitter taste. It is almost insoluble in water but soluble in diluted alcohol.

Dose—$\frac{1}{60}$ to $\frac{1}{40}$ grs.—0·001 to 0·0015 G. Initial dose.

$\frac{1}{240}$ grs.—0·00025 G. Maintenance dose twice daily.

$\frac{1}{120}$ to $\frac{1}{60}$ grs.—0·0005 to 0·001 G. by intravenous injection

ACTION OF DIGITALIS

External.—Digitalis leaves have no action on the unbroken skin but when applied to the denuded skin or mucous membrane they act as irritants producing partial paralysis of the sensory nerve endings.

Internal.—*Alimentary Tract.*—Digitalis, given by the mouth in moderately large doses, acts as a local gastro-intestinal irritant giving rise to salivation, nausea, vomiting and, more rarely diarrhœa. Later on, it may induce vomiting by central action.

Absorption and Elimination.—The active principles of digitalis are slowly absorbed from the small intestines and several doses must accumulate in the body before its effective dosage is reached to produce its full effects. They are partly destroyed in the intestines and partly excreted unchanged in the bile and kidneys. Their excretion is even slower than the absorption. Digitalis is therefore **cumulative** in effect. They circulate in the blood unchanged, without affecting it.

Circulatory System.—Digitalis after absorption, exerts its selective action on the circulatory system. It stimulates the vagus centre and the vagal nerve endings in the heart, as well as the cardiac muscles, and its progressive action on the circulation may be divided into (1) the initial Therapeutic Stage, (1) the transitory or Inhibitory Stage and (3) the final Toxic Stage.

THERAPEUTIC STAGE.—The effects of digitalis in this stage are seen in the slowing of the heart, and the increased force of contraction and regulation of its beats, against any previous irregularity. The slowing of the heart is brought about by lengthening the diastole through the stimulation of the vagal centre in the medulla, and also through the stimulation of the vagal endings in the heart. The increased force of its contraction is due to the direct action of the drug on the cardiac muscle as well as on the increased coronary circulation which improves the nutrition of the heart. During the diastolic period, owing to the complete relaxation of the muscle for a longer time than normal, the ventricles get filled in with blood to their fullest capacity and contract powerfully under its systolic action to propel every drop of blood into the arterial system. In frog the cardiac output in a given time is thereby increased more than normal, and causes the blood pressure to rise. The rise of blood pressure is further helped by the contraction of the systemic blood vessels through the stimulation of the vasomotor centre by increased arterial circulation. In man, however, in therapeutic doses, there is not sufficient concentration of Digitalis glucosides in the blood to stimulate the vasomotor centre or to contraction of the blood vessels by their direct action on the walls of arterioles. Therefore, no appreciable rise of blood pressure. The increased cardiac output at the periphery, which is also a factor in the causation of rise of blood pressure, is adjusted by the splanchnic dilatation which occurs reflexly by stimulating the depressors fibres going to the vasomotor centre. Digitalis, in addition to these actions, has a specific inhibitory action on the conducting tissue of the heart—the auriculo-ventricular bundle—which normally transmits the auricular impulses to the ventricles. The lowering of the conductivity of the bundle prevents the transmission of the abnormal impulses generated by the auricular fibrillations to the ventricles, which, devoid of auricular stimulation, begin to beat slowly at their own automatic rhythm and thus save the heart from the fatigue of overcontractions.

THE INHIBITORY STAGE.—If in spite of these full therapeutic effects, the administration of digitalis is persisted in, there occurs very great slowing of the heart, owing to the overstimulation of the vagal centre by improved circulation. The frequency of the pulse is diminished without interfering with its force. The cardiac output of the blood per minute is diminished ; and there is some fall in the blood pressure.

TOXIC STAGE.—In this stage the poisonous effects of digitalis on the cardiac muscles are manifested. Its irritability is much increased and is beyond the control of the vagus. The heart is accelerated, the ventricular output of blood is complete, and there is a rise of blood pressure. Later on the muscle of the heart is paralysed ; the contractions diminish in force and frequency, and become irregular ; the myocardium ultimately fails and the heart stops in diastole.

Respiratory System.—Digitalis in therapeutic doses stimulates the respiratory centre and respiration becomes rapid and deep. In poisonous doses the respiration fails through circulation.

Nervous System.—The central nervous system, in medicinal doses, is not affected by digitalis. In large doses, from disturbance of cerebral circulation, it causes headache, giddiness, and disturbance of sight and hearing.

Kidneys.—Digitalis acts as a powerful diuretic but not when the heart is normal, as it does not act directly on the renal cells. It is an effect secondary to the improvement of the circulation where that is defective. The venous congestion of the kidneys, consequent on defective circulation, causes a marked diminution in the secretion of the urine, and œdema of the body results. The powerfully acting heart improves the renal circulation and removes the venous stasis and lowers the pressure in the veins to absorb more fluid from the œdematous tissues. The resulting hydræmia increases the secretion of the urine. The diuretic effect of digitalis will thus depend on the amount of fluid in the tissues.

Temperature.—In small doses, digitalis has no effect on the temperature of the body. In toxic doses, the temperature is lowered, probably by central action. In fever, it acts as a refrigerant by causing loss of heat through the increased flow of blood in the peripheral blood vessels.

Cumulative Action.—Continuous administration of digitalis shows sudden symptoms of poisoning. This is a cumulative effect due to the slow excretion of the drug not keeping pace with its continuous administration. The earliest manifestations, which show that the administration of the drug is to be stopped, are nausea, vomiting, slow, and intermittent pulse, diminished quantity of urine and irregularity of cardiac beat.

THERAPEUTIC USES

Digitalis is indicated in all conditions in which circulatory failure is the cause of the ailment, provided there is no mechanical obstruction to the circulation and no pathological condition of the blood vessels or viscera, where rise of blood pressure is contra-indicated. It is, therefore, given to relieve pulmonary congestion, dyspnœa, venous engorgement, œdema and dropsy, which are the results of failing compensation in the valvular diseases of the heart. Digitalis is especially useful in auricular fibrillations of the heart. It partially blocks the abnormal impulses at the auriculo-ventricular bundle and causes the slowing of the ventricular beat. Digitalis is given in acute febrile diseases to tone the heart, and it is given in other functional diseases of the heart. It is also given in chronic Bright's Disease, and in chronic bronchitis which causes a continuous excessive strain on the heart. In acute inflammatory effects of the heart it is contra-indicated.

STROPHANTHUS

Strophanthus. *Synonym.*—Strophanthi Semina. The dried ripe seeds of *Strophanthus Kombe*, deprived of the awns. Crushed seeds have a characteristic heavy odour and bitter taste. It contains a white crystalline glucoside, ***strophanthin***, which is the active principle.

Tinctura Strophanthi.—10 per cent. in alcohol (70 per cent.)
Dose —2 to 5 ms.—0·12 to 0·3 mil.

Strophanthin.—It is a mixture of glucosides obtained from strophanthus. It occurs as a white or yellowish white powder in which minute crystals may be visible under the microscope. It is soluble in water and alcohol.

Dose—$\frac{1}{240}$ to $\frac{1}{60}$ gr.—0·00025 to 0·001 G. by intramuscular or intravenous injection.

ACTION AND THERAPEUTIC USES OF STROPHANTHUS

Strophanthus has an action similar to that of digitalis and its therapeutic indications are also the same. It, however, differs from digitalis in the following points :—(1) It acts more quickly than digitalis. In auricular fibrillation, it is of special benefit and affects the heart within about half an hour if administered as an injection of strophanthin. (2) Its effects are not lasting nor cumulative as its absorption and elimination are quicker. (3) It is not irritating to the alimentary canal. (4) It is a better diuretic and may be given in advanced organic kidney affections, when the administration of digitalis is contra-indicated. (5) It causes less contraction of the arteries, so that it adds less to the work of the heart. It is, therefore, especially indicated in the cardiac feebleness of aged persons.

SQUILL

Scilla. *Synonym.*—Scillæ Bulbus. The dried fleshy inner scales of the bulb of *Urginea Scilla.* Odour slight ; taste bitter and acrid. Its chief constituents are *Scillitoxin* or Scillin, a glucoside, the active principle and *Scillipicrin* closely related to the first.

Dose—1 to 3 grs.—0·06 to 0·2 G.

1. **Acetum Scillæ.**—It is about 10 per cent. solution in dilute acetic acid.

   Dose—10 to 30 ms.—0·6 to 2 mils.

2. **Oxymel Scillæ.**—It is a mixture of Acetum Scillæ and honey, in the proportion of 1 to 2½.

   Dose—½ to 2 fl. drs.—2 to 8 mils.

3. **Syrupus Scillæ.**—It is about 45 per cent. solution of Acetum Scillae in simple syrup.

   Dose—½ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Scillæ.**—10 per cent. in alcohol (60 per cent.).

   Dose—5 to 30 ms.—0·3 to 2 mils.

5. **Extractum Scillæ Liquidum.**—In equal parts squill and alcohol (70 per cent.). This extract has ten times the strength of tincture.

   Dose—½ to 3 ms.—0·03 to 0·2 mils.

ACTION AND THERAPEUTIC USES OF SQUILL

Squill, belonging to the digitalis group, has action similar to digitalis or strophanthus on the heart, but its use is restricted to the cardiac affections complicated by marked œdema. It is a **gastro-intestinal irritant** in full therapeutic doses, and may induce nausea, vomiting and diarrhœa. It stimulates the secretion of the bronchial mucous membrane directly, during the process of excretion through it, and not merely by simple nauseant action. It thus acts as an **expectorant.** Owing to its irritant action on the kidney cells and also to its being a cardiac tonic, it is a more energetic **diuretic** than other substances of the digitalis group. It is contra-indicated in the acute inflammatory conditions of the lungs and kidneys. It is a valuable drug in the chronic inflammatory conditions of these organs when their secretion is scanty.

Class II

CARDIAC DEPRESSANTS

Aconite and Veratrine are powerful cardiac depressants. They reduce the force and frequency of cardiac beat, slow the pulse and cause blood pressure to fall. Of these two, **only Aconite is official** but it is rarely used as a therapeutic agent for its effects on the system, as the margin of safety between the therapeutic and toxic doses is very little. It is described for its other effects on page 285.

GROUP IV

DRUGS ACTING MAINLY ON THE ARTERIES

Class I.—Vaso-constrictors—contract the arterioles and raise the blood-pressure, *e.g.*, Ephedrine, Adrenaline, Pituitary.

Class II.—Vaso-dilators—dilate arterioles and lower the blood-pressure, *e. g.*, Nitrites.

Class I

VASO-CONSTRICTORS

EPHEDRINE

Ephedrina.—It is an alkaloid obtained from *Ephedra Sincia* and other species of *Ephedra*. It occurs in hexagonal and prismatic crystals. It is readily soluble in water and alcohol.

Dose—¼ to 1½ grs.—0·016 to 0·1 G.

Ephedrinæ Hydrochloridum.—The hydrochloride of the alkaloid Ephedrine obtained from *Ephedra Sincia* and other species of *Ephedra*. It occurs in prismatic crystals soluble in water and alcohol.

Dose—¼ to 1½ grs.—0·016 to 0·1 G.

External.—Ephedrine has no action on the unbroken skin. Applied to raw or mucous surfaces, it constricts the blood vessels, as adrenaline but the effects are not so powerful or transient.

Internal.—All the systemic effects produced by ephedrine are due to the stimulation of the sympathetic nerve endings. But according to some, the real point of attack is not on the myoneural junction, as in the case of adrenaline, but on the muscle cell itself.

Alimentary Tract.—Ephedrine, given by the mouth, constricts the blood vessels of the stomach, diminishes its secretion and retards digestion. It lessens the tonus and movements of the bowels and does not influence the secretion of the bile, pancreas and intestines.

Absorption and Elimination.—It is slowly, yet completely absorbed into the system when given by the mouth ; but the absorption is quicker when administered by subcutaneous injection. The excretion is prompt probably by the kidneys, as evidenced by the slight diuresis it produces.

Circulatory System.—The most **striking effect** of ephedrine on the circulation is **the rise of blood pressure** due to an increase in the rate and force of the heart and constriction of the blood vessels of the splanchnic area. Later on with the rise of blood pressure there is slowing of the heart due to the stimulation of the vagal centre. These effects on circulation are more persistent than in adrenaline.

Respiratory System.—In small doses, ephedrine has almost a selective action on respiration. It contracts the nasal mucosa, and it **relaxes the bronchial muscles,** an effect which is most marked when the bronchial spasm is present as in the case of asthma. It increases the bronchial secretion. In moderate doses, the respiratory centre is stimulated but it is depressed by large ones, and the respiration ceases even before the heart stops.

Urinary System.—In small doses, the blood flow through the kidneys is increased to cause diuresis. In large doses, the secretion of the urine is diminished due to renal anæmia. There may be albumen in the urine, and degenerative changes in the kidney cells. There may be glycosuria probably due to the defective metabolism of carbohydrates, with consequent rise of sugar in the blood. The bladder muscles are contracted.

Uterus.—Ephedrine, as it does on other involuntary muscles, contracts the muscle of the uterus.

Central Nervous System.—In therapeutic doses, the central nervous system is not markedly affected; but in some it causes insomnia, great restlessness, anxiety and motor agitation with inability to lie still. In large doses, there may be clonic convulsions due to the stimulation of the lower brain centres.

Eye.—Ephedrine produces its characteristic effects when instilled into the eye in the form of 2 to 4 per cent. solution. It **dilates the pupil** by the stimulation of the endings of the sympathetic nerves of the dilator fibres. However, like atropine, **it does not paralyse the accommodation, nor does it increase the intraocular tension.** The dilatation of the pupil is temporary and not persistent as in the case of atropine. The pupil regains its normal size in about 10 hours.

THERAPEUTIC USES

Locally, Ephedrine is used to relieve the congestion of the nasal mucous membrane, as the shrinkage it causes is greater

than even what is caused by cocaine or adrenaline. In the form of eye-drops it is preferred to homatropine or atropine when the increased tension is undesirable and when it is not necessary to paralyse accommodation. Internally, it is very largely used either alone, or in combination with adrenaline, to relieve the spasms of asthma. It is also used to relieve the allergic phenomena of angioneurotic œdema, urticaria and congestive migraine. It has besides been used with good effect to prevent surgical shock.

ADRENALINE

Adrenalina. *Synonyms.*—Adrenalinum ; Adrenaline ; Adrenine ; Epinephrine and Hemisine. Obtained from the *medulla of Suprarenal Gland* or prepared by synthesis. It occurs as a white crystalline powder, sparingly soluble in water but readily soluble in weak mineral acids.

Dose—$\frac{1}{600}$ to $\frac{1}{120}$ grs.—0·0001 to 0·0005 G.

Liquor Adrenalinæ Hydrochloridi.—0·1 per cent. preserved with chlorbutol.

Dose—2 to 8 ms.—0·12 to 0·5 mil.

Injectio Procainæ et Adrenalinæ.—It contains 2 per cent. of Procain Hydrochloride. (See Procaine Hydrochloridum.)

ACTION OF ADRENALINE

External.—It has no action on the unbroken skin. Applied to raw or mucous surfaces, it constricts the blood vessels and prevents hæmorrhage. Combined with local anæsthetics, it enhances their action and prevents their absorption.

Internal.—All the systemic actions of Adrenaline are due to the stimulation of the receptor substances of all sympathetic between myo-neural junctions, whether they be accelerator or inhibitor. In this, it differs from ergotoxine, which only stimulates the accelerator receptor between myoneural junctions.

Alimentary Tract.—Taken by the mouth, adrenaline constricts the blood vessels of the stomach and arrests bleeding. Beyond this, no other systemic effect is seen, as the drug is destroyed before or during absorption. To obtain a full systemic effect, the drug is best administered by the subcutaneous or the intravenous method and then it inhibits the movements of the intestines by the stimulation of the myo-neural junction in the muscular fibres of the intestines. It, however, contracts all the sphincter muscles of the intestines, which receive only the motor fibres of the sympathetic. The secretion of the stomach and intestine is not influenced probably on account of anæmia caused by the constriction of the blood vessels. There is increased destruction of glycogen liberating glucose, which is found to an excessive extent in the blood and tissues, and causes glycosuria.

Absorption and Elimination.—It is not absorbed from the unbroken skin or from the gastro-intestinal tract. But when topically applied to serous membranes, or to mucous membranes, particularly of the nose, throat or rectum, it exerts its systemic action by quick absorption like that of a subcutaneous injection.

Circulatory System.—After absorption, its most striking action is the stimulation of the circulatory system. The immediate effect is seen in the augmentation and acceleration of the heart beat by the stimulation of the accelerator myoneural junction in the heart. The blood vessels, particularly of the splanchnic area and skin, are also constricted by the same action, and thus become instrumental in preventing the outflow of blood to the veins. In consequence of the stimulation of the heart and constriction of the blood vessels, the blood pressure rises, which in turn stimulates the vagal centre in the medulla, and thus it reflexly slows the heart. These effects are, however, transitory, and last only as long as adrenaline remains in combination with the receptors between myo-neural junctions; and pass off when it is destroyed in the body. The blood vessels of the lungs, having a poor sympathetic supply, are little affected; the arterioles of the cerebral cortex are slightly constricted or passively dilated; the coronary artery, having an innervation from the vagus and sympathetic endings, dilate under the stimulation of the sympathetic.

Respiratory System.—Adrenaline, by stimulating the sympathetic endings, **relaxes the bronchial muscles,** and increases the secretion of bronchial mucous.

Involuntary Muscles.—The action of adrenaline on the plain muscles of the heart, stomach, intestines and bronchioles is already described. It acts similarly on the receptor between myo-neural junctions of the other plain muscle in the body. It thus contracts the uterus, vagina, ureter and bladder. It dilates the pupil, retracts the upper eye-lid and causes bulging of the eye-ball.

Skeletal Muscles.—Adrenaline, by improving the blood supply to the skeletal muscles, increases their power to put in more work and diminishes the effect of fatigue.

Glands.—The action of adrenaline on the glands is not so important and powerful as that of pilocarpine, as the glandular secretions are influenced less by the sympathetic than by parasympathetic nerves. It increases, however, the secretions of glands which receive their sympathetic supply *via* blood vessels and this applies to the secretory glands in the mouth,—salivary and mucous. The flow of urine is increased by small doses of adrenaline; while large doses constrict the renal vessels, and the diminished blood flow to the kidneys lessens the amount of urine. It causes glycosuria.

THERAPEUTIC USES

Adrenaline is widely used as a local hæmostatic to stop bleeding from the nose, throat, stomach and uterus. It is mixed with solutions of local anæsthetics to heighten their action. It is injected hypodermically to relax bronchial spasm and to cut short an attack of asthma. The injections are also useful to revive a patient from an anaphylactic shock, Intravenously, it is often used to raise the blood pressure, and to stimulate the heart in cases of circulatory failure. It should not be used in arterio-sclerosis where there is risk of sudden rise of blood pressure. In pulmonary hæmorrhage there is the risk of increasing the hæmorrhage by raising the pulmonary pressure.

PITUITARY EXTRACT

Extractum Pituitarii Liquidum. *Synonyms.*—Pituitrin ; Liquor Pituitarii. It is prepared from the posterior or infundibular lobe of the pituitary body of oxen or other mammals. It contains Vaso-pressin (Pitressin) a substance which is a capillary contractor ; Oxytocin, (Pitocin), which stimulates the contraction of the uterus ; and a third substance which influences diuresis. Pituitary extract is always given subcutaneously in doses of 1 c.c. containing about 3 grains of the extract. It is standardised physiologically by its effects on the uterus of a guinea pig.

Dose—3 to 7 ms.—0·2 to 0·5 mil.
2 to 5 units by injection.

ACTION AND THERAPEUTIC USES

Pituitary extract acts by exerting a direct stimulant action on the smooth muscles of the body, particularly of the arterioles, uterus and intestines, and bears no relation to their innervation.

The contraction of arterioles by its direct action on the muscular coat raises the blood pressure, which, unlike by adrenaline, is maintained for a long time. Consequent on this rise of blood pressure, the vagal centre in the medulla is stimulated to slow the heart and the force of its contraction is increased by the direct action of pituitrin on the muscle of the heart. It is, therefore, **used to raise the blood pressure** in cases of shock and collapse.

The uterus contracts powerfully and promptly under the influence of Pituitrin, acting best if the parturition has commenced. It is therefore used in cases of uterine inertia, to shorten the third stage of labour and to check post-partum hæmorrhage. It increases the flow of milk without increasing its secretion by contraction of the plain muscular fibres of the mammary gland.

Pituitary stimulates the movement of the intestines and is used in cases of intestinal atony, and to rouse the dormant contractions of the intestines in cases of inertia after abdominal operations.

Under the normal conditions of the kidneys, pituitrin increases the secretion of urine, even in spite of the fall in blood pressure which is seen after the administration of the second dose within 2 hours after the administration of the first. In abnormal conditions of the kidneys, as in diabetes insipidus, it diminishes the urinary secretion and thirst. How it acts as a **diuretic** and **anuretic** under certain conditions is not definitely known. There is, however, evidence to suppose that there exists in the brain a centre which regulates the water exchange between the capillaries and the tissues. Pituitary extract inhibits the activity of the centre when the volume of kidney secretion is increased in certain diseases, as in diabetes insipidus, and increase the capacity of tissues for holding water. Thus it acts as an anuretic.

The smooth muscle of the bladder is stimulated. The action of pituitrin on the bronchial muscles is still in dispute ; probably it relaxed them, and, therefore, proves beneficial in asthma. The pupils are dilated by pituitrin.

Class II

VASO-DILATORS

NITRITES

1. Amyl Nitris.—Amyl Nitrite. A clear, yellowish, volatile liquid, with a peculiar fruity odour, like that of an over-ripe pear. Almost insoluble in water but miscible with alcohol and ether.

Dose—2 to 5 ms.—0·12 to 0·3 mil. by inhalation.

For convenience, it is put in 3 ms. dose in tiny thin glass capsules which can be broken with slight pressure in a handkerchief.

2. Glycerylis Trinitratis.—Glyceryl Trinitrate. *Synonyms.*—Nitroglycerine, Trinitrini, Glonoin. It is a highly explosive, colourless liquid, silghtly soluble in water but easily in fats, oils, alcohol and ether.

1. Liquor Glycerylis Trinitratis. *Synonym.*—Liquor Trinitrini. It is a 1 per cent. solution of nitro-glycerine in alcohol (90 per cent.).

Dose—½ to 2 ms.—0·03 to 0·12 mil.

2. Tabella Glycerylis Trinitratis. *Synonym.*—Tabellæ Trinitrini. Each contains 1/120 gr. of glyceryl trinitrate with a chocolate base, as with it there is vey little risk of explosion.

Dose—1 to 2 tablets.

3. Sodii Nitris.—Sodium Nitrite. Occurs as white sticks or crystals, very readily soluble in water.

Dose—½ to 2 grs.—0·03 to 0·12 G.

4. Erythritylis Tetranitras Dilutus.—Diluted Erythrol Tetranitrate (50 per cent.). *Synonym.*—Erythrol Tetranitrate (50 per cent.). It occurs as a white powder, almost odourless and tasteless, except for the sweet taste of lactose. It is a mixture of erythrityl tetranitrate and lactose. It is partially soluble in cold water and in alcohol (90 per cent.).

Dose—½ to 2 grs.—0·03 to 0·12 G.

representing — representing
¼ to 1 gr. — 0·015 to 0·06 grms.
of Pure Erythrityl Tetranitrate.

5. Spiritus Ætheris Nitrosi.—Spirit of Nitrous Ether. *Synonym.*—Sweet Spirit of Nitre. It is an alcoholic solution containing about 2·5 per cent. of ethyl nitrite. It is a clear mobile liquid of a pale yellow or greenish yellow colour, having a sharp burning taste and apple like odour.

Dose—15 to 60 ms.—1 to 4 mils.

6. **Liquor Æthylis Nitritis Concentratus.**—It is a concentrated solution of Ethyl Nitrite in alcohol (95 per cent.). It has eight times the strength of spirit of Nitrous Ether.

Dose—2 to 8 ms.—1·25 to 0·5 mils.

ACTION OF NITRITES

The action of Amyl-nitrite is typical of all nitrites. The other members of the group differ from it in intensity, rapidity and duration of action.

External.—Nitrites are not used externally, though amyl nitrite by direct action depresses the sensory nerve endings, but this effect is very transitory.

Internal.—*Alimentary Tract.*—All nitrites, given in large doses, act as gastro-intestinal irritants giving rise to pain and indigestion. The secretion of saliva is increased by a direct action on the gland cells. They inhibit peristalsis by relaxing the muscles of intestines.

Absorption and Elimination.—Amyl nitrite is administered by inhalation and is promptly absorbed by the lungs. Other nitrites are absorbed from the mouth and stomach. In the body, they undergo partial oxidation and appear in the urine both as nitrates and nitrites; but the quantity excreted is not equal to the quantity absorbed. This is probably due to some quantity being destroyed in the body. Amyl nitrite is excreted in the same way amyl radical being completely absorbed.

Blood.—Nitrites in small doses do not materially affect the blood after absorption, but if a considerable quantity is absorbed, they convert the hæmoglobin of the red blood corpuscles into methæmoglobin, and to a small extent, into nitrous oxide hæmoglobin. The oxygenating power of the blood is thereby interfered with. The blood in the arteries and veins assumes a uniform chocolate colour. In fatal poisoning by the nitrites this alteration is the cause of death.

Circulatory System.—The most striking effect of amyl nitrite and other nitrites is the **fall of blood pressure** which follows their use. This is due to the paralysing effect they exert on the walls of the vessels, and probably on the muscle itself, and as a result of this, dilatation of the arterioles occurs. This dilatation is most marked in the vessels of the skin, particularly of the head and neck, and of the brain and meninges as is seen in the flushing of the face, the visible pulsation of the carotids, throbbing of the head, giddiness, and dilatation of the pupils. The dilatation, however, does not remain confined to the vessels of the skin, but spreads to other vessels; and the relaxation of the blood vessels of the splanchnic area in particular, causes a speedy fall in the blood pressure. The coronary arteries are also dilated, but owing to the fall in blood pressure the blood flow in them is reduced. There is no marked relaxation of pulmonary blood vessels and the blood pressure within them may rise, owing to the increased cardiac output from the increased return of venous blood to the heart. In the case of amyl-nitrite the effects produced is immediate, and reaches its maximum in ½ to 1 minute and lasts for 5 to 10 minutes.

The heart is reflexly quickened by the fall of blood pressure which induces anæmia of the brain, depresses the inhibitory vagus centre and probably excites the accelerator mechanism; but the force of its contraction is lessened owing to the direct depressing action of the nitrites on the myocardium. The pulse, therefore, is quickened but its force and tension are not altered. In toxic doses, the heart may get arrested in the diastole.

Respiratory System.—The immediate effect of nitrites and particularly of amyl nitrite, is the increase in the number and depth of respiration due to the stimulation of the respiratory centre by the fall in blood pressure. If the inhalations of Amyl nitrite are continued long, the respirations become slower and shallower, the patient gets cyanosed and dies from asphyxia. The bronchial muscles are relaxed.

Temperature.—Amyl nitrite and other nitrites cause the temperature to fall both in fever and in health, owing to the peripheral vascular dilatation, and in large doses, to the changes in the blood.

Nervous System.—In small doses nitrites have no effect on the nervous system apart from the medulla. The throbbing of the head, giddiness, headache, ataxia, etc., are all secondary effects of the dilatation of the blood vessels of the brain and spinal cord. The dilatation of the pupils and the disturbances of vision are due to the specific paralysing action of the nitrites on the endings of all inhibitory nerves. In larger concentration the motor centres in the spinal cord are directly and profoundly depressed. The reflex action is therefore abolished. Similar but less powerful action is exerted on the nerve trunks and muscles. Sensory nerves are but little affected. It is believed that to one under the influence of amyl nitrite everything appears yellow.

Urine.—Nitrites have no direct action on the renal cells but cause diuresis by dilating the renal vessels and increasing the flow of blood.

Glyceryl Trinitrate.—Next to amyl nitrate, it is the most rapidly acting of the nitrites. It may be administered by inhalation or by drops underneath the tongue or by injection. It is rapidly absorbed in the blood unchanged, and is then broken up at once into glycerine nitrite and nitrates. The maximum dilatation of the blood vessels is reached within about 4 or 5 minutes and lasts for about an hour. As compared with amyl nitrite, its action is more prolonged. Its disadvantage is that it causes severe headache particularly of the frontal type which lasts for some time after the other effects are worn away. Death from Glyceryl Trinitrate is not due to the formation of methæmoglobin.

Sodium Nitrite.—It is absorbed slowly, taking about half an hour to cause the maximum dilatation of the vessels; but its effects are more powerful and lasting. It liberates in the stomach nitrous acid and it may cause gastric irritation.

Spirit of Nitrous Ether.—It combines the properties of ether and nitrites. It is a diffusible **stimulant** and **carminative.** It acts as a **diaphoretic** and **diuretic.** Its power of reducing the blood pressure is slow but persistent and at the same time it accelerates the heart.

THERAPEUTIC USES

Nitrites are used to cut short an anginal attack and they act by relaxing the coronary arteries. Amyl Nitrite is used during the attack because of its prompt action when inhaled, and the other nitrites are used during the intervals of the attacks. Amyl Nitrite is also used, to avert an attack of epilepsy as soon as the premonitory symptoms begin to manifest themselves in asthma, in chloroform poisoning and deep seated hæmorrhages. Being evanescent in its action, it is of no value in lowering the blood pressure. Other nitrites are mainly used to lower the blood pressure, to reduce peripheral resistance in a weak heart, in hamoptysis; to reduce spasms of the uterus in dysmenorrhœa, in neuralgia, epilepsy, colic, etc. Spirit ætheris nitrosi is used, to reduce the febrile temperature, to act as a diuretic, in chronic diseases of the kidneys, in cardiac diseases, etc. It is also given to reduce the spasm of asthma.

GROUP V

DRUGS, OTHER THAN VOLATILE OILS, ACTING CHIEFLY ON THE RESPIRATORY TRACT

Senega Quillaia, Ipecacuanha, Lobelia, Virginian Prune

SENEGA

Senega. *Synonym.*—Senegæ Radix. The dried root of *Polygala Senega.* It has a peculiar penetrating odour; its taste is sweetish and acrid. The chief constituents are two glucosidal saponins, *senegin* and *polygalic acid*, which are identical with the saponin found in saponaria and other plants.

1. **Extractum Senegæ Liquidum.**—Obtained by exhausting powdered senega root with alcohol (60 per cent.) and adding dilute solution of ammonia.

Dose—5 to 15 ms.—0·3 to 1 mil.

2. **Tinctura Senegæ.**—20 per cent. in alcohol (60 per cent.)

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Infusum Senegæ Recens.**—5 per cent. in boiling water.

Dose—½ to 1 fl. oz.

4. **Infusum Senegæ Concentratum.**—Prepared by exhausting 400 grms. of senega in alcohol (25 per cent.) and diluting with solution of ammonia until the product is faintly alkaline.

Dose—½ to 1 fl. dr.—2 to 4 mils.

Action of Senega

The external and internal actions of senega are due to the saponins in its composition. They act as general protoplasmic poisons and irritants. They combine with lipoids and alter the physical properties of cell membranes.

External.—Senega irritates the skin causing inflammation by prolonged application.

Internal.—*Alimentary Tract.*—Senega in small doses may upset digestion. In large doses, it is a gastro-intestinal irritant, producing salivation, nausea, vomiting and diarrhœa.

Absorption and Elimination.—Saponins are mainly destroyed by the digestive ferments and as a rule produce very little systemic effect when swallowed. The absorbed portion is excreted mainly by the bronchial mucous membrane, skin and the kidneys. If injected, they circulate in the blood as such and cause hæmolysis of the red blood cells.

Circulatory System.—Saponins have very little effect on the circulation when given by the mouth. If injected, they poison the heart muscle and stop the heart in diastole.

Respiratory System.—Powdered root, when inhaled causes sneezing and coughing by its irritant action on the respiratory mucous membrane. During its process of excretion through the lungs, it increases the bronchial secretion, which reflexly stimulates cough. It, therefore, acts as a stimulating **expectorant.**

Urinary System.—Kidney cells are likewise stimulated to cause diuresis often accompanied by albuminuria. It is, however, not used therapeutically for this purpose.

THERAPEUTIC USES

Senega is mainly used as an expectorant, in cases of subacute and chronic bronchitis, when the secretion is scanty and the power to cough is feeble. Being an irritant, it should be avoided in acute dronchitis.

QUILLAIA

Quillaia. *Synonym.*—Quillaiæ Cortex. The dried inner part of the bark of *Quillaia Saponaria.* The chief constituents are two colourless, amorphous, toxic glucosides, *quillaia sapotoxin* and *quillaiac acid*, which both impart the property of frothing to water.

Dose—1 to 3 grs.—0·06 to 0·2 G.

1. **Extractum Quillaiæ Liquidum.**—Equal parts of Quillaia and Alcohol (45 per cent.). This extract has twenty times the strength of tincture of quillaia.

Dose—1½ to 3 ms.—0·1 to 0·2 mil.

2. **Tinctura Quillaiæ.**—5 per cent. solution in alcohol (45 per cent).

Dose—½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

Quillaia bark possesses the property of forming a frothy solution in water and hence the tincture of quillaia is largely used as an emulsifying agent for tar, oils, resins, etc. By virtue of the saponin it contains it acts as an expectorant like senega. It is used as a cleansing agent and as an aid in the formation of foam, as in shampoos and shaving creams.

IPECACUANHA

Ipecacuanha. *Synonym.*—Ipecacuanhæ Radix. The dried root of *Cephælis Ipecacuanha.* The root is twisted, thin, annulated, reddish brown in colour; taste bitter, nauseous and acrid. It contains three alkaloids, *emetine, cephæline, psychotrine* and a *tannin.* The medicinal virtues reside chiefly in the alkaloids emetine and cephæline. It contains not less than 2 per cent. of total alkaloids, calculated as emetine.

1. **Ipecacuanha Pulverata.** Powdered Ipecacuanha. *Synonym.*—Pulvis Ipecacuanhæ. In 2 grains it contains about $\frac{1}{25}$ gr. of the total alkaloids calculated as emetine.

Dose—½ to 2 grs.—0·03 to 0·12 G. as an expectorant.
15 to 30 grs.—1 to 2 G. as an emetic.

2. **Extractum Ipecacuanhæ Liquidum.**—Made by digesting a definite quantity of powdered Ipecacuanha with alcohol (90 per cent.), filtered and assayed for total alkaloids about 2 per cent.

Dose—½ to 2 ms.—0·03 to 0·12 mil. as an expectorant.
10 to 30 ms.—0·6 to 2 mils. as an emetic.

3. **Tinctura Ipecacuanhæ.**—5 per cent. of the liquid extract in distilled water with 20 per cent. of alcohol and glycerine each. Contains 0·1 per cent. of the total alkaloids.

Dose—10 to 30 ms.—0·6 to 2 mils. as an expectorant.
½ to 1 fl. oz.—15 to 30 mils. as an emetic.

4. **Pulvis Ipecacuanhæ et Opii.** *Synonym.*—Pulvis Ipecacuanhæ Compositus, Dover's Powder. Contains 10 per cent. each of powdered Ipecac and Opium with Lactose.

Dose—5 to 10 grs.—0·3 to 0·6 G.

5. **Trochiscus Morphinæ et Ipecacuanhæ.**—Contains ¼ gr. of Ipecacuanha and $\frac{1}{36}$ gr. of morphine hydrochloride.

Emetinæ Hydrochloridum.—It is the hydrochloride of an alkaloid emetine, which may be obtained from the Ipecacuanha root, or prepared by methylation of cephæline. It occurs as a white crystalline powder acquiring a yellow tint on exposure to light. It is odourless and has a bitter taste, soluble in water.

Dose—½ to 1 gr.—0·03 to 0·6 G. Generally given by subcutaneous injection.

Emetinæ et Bismuthi Iodidum. Emetine and bismuth iodide. It contains about 27 per cent. of emetine and about 20 per cent. of bismuth. It occurs as a reddish orange powder without any odour. The taste is bitter and acrid, and it is insoluble in water and alcohol.

Dose—1 to 3 grs.—0·06 to 0·2 G.

ACTION OF IPECACUANHA

External.—Crude ipecacuanha is the most powerful irritant to the skin producing redness, vesication and pustulation. Its alkaloid emetine has some power to destroy micro-organisms, but not the dysenteric amœbæ in broth culture, even in moderately strong solution.

Internal.—*Alimentary Tract.*—Ipecacuanha, directly, as well as reflexly, produces salivation in the mouth. Reaching the stomach in small doses, it stimulates the gastric mucous membrane, producing dilatation of the local blood vessels and increase in the secretion of the gastric juice. It thus acts as a **stomachic.** In large doses, it irritates the stomach and acts as a direct **emetic.** Some of the alkaloidal portion of ipecacuanha, however, is absorbed into the circulation before it is thrown out of the stomach with vomiting; and it stimulates the vomiting centre in the medulla to induce vomiting. The absorbed emetine is partly excreted into the stomach and acts as an emetic once more by its local action. Ipecacuanha is thus a local as well as a central emetic, producing repeated vomiting, accompanied by depression and muscular weakness, within about half an hour of its administration. In the intestines, ipecacuanha in small doses, increases the secretion of mucous, and in doses just short of causing vomiting, it **increases the secretion of bile** and irritates the intestinal tract producing **diarrhœa.** The major portion of the absorbed emetine is excreted in the intestines to produce the same irritant as well as its specific action there, **in curing amœbic dysentery.** Emetine *in vitro* is not toxic to amœbæ and how it effects a cure in man is not known.

Absorption and Elimination.—The alkaloids of ipecacuanha are absorbed from the gastro-intestinal tract but none of the alkaloid is found in any of the excreta even when given in large doses. They are perhaps stored up in the body in an altered condition and this may account for the cumulative action of ipecacuanha. A portion of them is excreted by the bronchial mucous membrane. Emetine, however, when given by an injection is excreted by the intestines and by the kidneys.

Circulatory System.—In stomachic doses, the heart is not affected. In large doses, it depresses the heart and the blood pressure falls. It is said to constrict the blood vessels by its local action.

Respiratory System.—Inhalation of powdered ipecacuanha causes irritation of the entire respiratory tract, with coryza sneezing, lachrymation and coughing. During the process of its excretion it irritates the bronchial mucous membrane, to produce increased secretion which induces reflex cough. It is, therefore, an **expectorant.** As compared with apomorphine, it is less prompt in action, and with tartar emetic it is less depressant.

Skin.—In moderate doses, it acts as a **diaphoretic** and this action is increased by its combination with opium.

THERAPEUTIC USES

Ipecacuanha in minute doses acts as a gastric sedative and is given especially to check vomiting in the early months of pregnancy. It is used mainly as an expectorant in the bronchitis of children in the form of vinum now Tinctura ipecac. Large doses of the Tincture are given as an emetic to children in acute bronchitis when the small bronchial tubes are clogged by secretion. In nauseant doses, it is given to increase the secretion of the bronchial mucous membrane, when it is tenacious and scanty. Injections of emetine are used for the cure of amœbic dysentery. Ipecacuanha in the form of powder is administered in the torpid condition of the liver, and in jaundice.

Chiniofonum. *Synonyms.*—Pulvis chiniofoni, Loretin, Quinoxyl, Yatren. It contains 28·2 to 29·6 per cent. of Iodine and 18 to 22 per cent. of hydroxy quinoline-sulphonic acid. It occurs as a light yellow, odourless powder, with a taste at first bitter, subsequently sweetish. Soluble with effervescence, in about 25 parts of water ; insoluble in alcohol, in ether and in chloroform. Aqueous solutions are decomposed by boiling.

Dose—1 to 8 grs.—0·06 to 0·5 G. orally.
15 to 75 grs.—1 to 5 G. by rectal injection.

ACTION AND THERAPEUTIC USES OF CHINIOFON

Its chief use is in amœbic dysentery in which 6 to 8 grains are given three times a day for about a week and repeated after intervals of a week. It is also given as an enema in conjunction with emetine, of 2 per cent. solutions and should be retained as long as possible. Externally chiniofon has antiseptic powers, as a dusting or application of 2 per cent. solution for wounds and inflammations of mucous membranes.

LOBELIA

Lobelia. *Synonym.*—Lobeliæ Herba. The dried flowering herb of *Lobelia inflata.* The odour is slight but irritating ; and the taste markedly acrid and burning. It contains a volatile liquid alkaloid, *lobeline,* having a pungent taste and odour like tobacco. It is found combined with *lobelic acid* and forms of crystallizable salts.

Tinctura Lobeliæ Ætherea.—20 per cent. in spirit of ether.

Dose—5 to 15 ms.—0·3 to 1 mil.

Tinctura Lobeliæ Ætherea Concentrata.—It has approximately four times the strength of Ethereal Tincture of Lobelia.

Dose—1 1/3 to 4 ms.—0·08 to 0·25 mil.

ACTION OF LOBELIA

External.—None.

Internal.—*Nervous System.*—The chief action of lobelia is on the nervous system, and through it, it influences the other systems in the body. In moderately large doses, it stimulates and then depresses the medullary centres of the central nervous system and the ganglionic cell stations of the autonomic nervous system. It thus closely resembles nicotine (non-official) in its action.

Alimentary Tract.—In therapeutic doses lobelia has very little effect on the gastro-intestinal tract, except perhaps vomiting caused by the direct stimulation of the vomiting centre. In large doses, it causes powerful contractions of the stomach and intestines from the stimulation of the sympathetic ganglia in their walls, and as a result there is vomiting and purging. Later on the ganglia are depressed and all reflex peristalsis is abolished. These effects are generally accompanied by intense prostration with side symptoms of collapse, as shown by feeble pulse, cold sweats, pale skin and great muscular weakness.

Circulatory System.—Lobelia, as it stimulates the vagal centres and vagal ganglia in the heart, causes the heart to become slow and weak; but soon the ganglia are paralysed and the heart begins to beat rapidly. The preliminary fall in the blood pressure is soon followed by a rise by stimulation of the vaso-constrictor ganglia.

Respiratory System.—In small doses, lobelia stimulates the respiratory centre and the vagal ganglia, and increases the rate and depth of respiration and causes transient constriction of the bronchioles, which are subsequently relaxed by their depression. In large doses, both are paralysed. Respiration, therefore, becomes slow and shallow, asphyxia results, and death occurs from respiratory failure.

Secretions.—Lobelia in moderate doses increases the secretion of saliva, sweat and the bronchi; in large doses it diminishes them.

THERAPEUTIC USES

The chief therapeutic use of lobelia is to diminish the spasm of asthma by relaxing the bronchial muscle and by increasing the bronchial secretion. Lobelia is a useful expectorant in bronchitis with scanty expectoration; and it is of value in the treatment of whooping cough. In chronic constipation, a ten minims dose of the tincture will often bring about the regular action of the bowels without inducing a drug habit. Pure crystalline lobeline (1/6 gr.) is injected to stimulate the respiratory centre in narcotic poisoning.

BENZYL BENZOATE

Benzylis Benzoas. *Synonym.*—Spasmodin. It occurs in colourless crystals or oily liquid, odour aromatic; taste sharp and burning; freely soluble in alcohol and ether.

Dose—5 to 8 ms.—0·3 to 0·5 mil.

ACTION AND THERAPEUTIC USES

Benzyl Benzoate relaxes spasm in involuntary muscles by direction action. It stimulates bronchial mucous membrane, during excretion and it is, therefore, an *expectorant*. It acts as a *parasiticide* on sarcoptes hominis.

It is used for the relief of spasmodic asthma, whooping cough, colic in any form. It is mainly used as a cure of scabies.

WILD CHERRY

Prunus Serotina. *Synonym.*—Pruni Virginianæ Cortex. The stem bark of *Prunus Serotina*, the wild cherry, collected in autumn and carefully dried. It is reddish brown in colour having transversely elongated lenticles. The odour is slight; taste astringent, aromatic and bitter, like bitter almonds. It contains a bitter principle, *Amygdalin*, similar to that in bitter almonds, which yields a *volatile oil* and *hydrocyanic acid* on distillation.

Dose—15 to 30 grs.—1 to 2 G.

Syrupus Pruni Serotinæ.—Prepared by macerating 15 per cent. of the bark in sugar, glycerine and water.

Dose—½ to 1 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

Wild cherry bark, owing to a little hydrocyanic acid in it acts as a *sedative expectorant* by diminishing the reflex irritability of the cough centre. Owing to the presence of a volatile oil, the syrup is a useful *flavouring agent* for cough mixtures.

GROUP VI

DRUGS ACTING MAINLY ON THE ALIMENTARY CANAL

The drugs given by mouth exert some action on the alimentary canal, but with a majority of them that action is incidental to their specific actions on one system or another, for which they are administered. In this group, only such drugs will be considered as influence the functions of the alimentary canal by stimulating or depressing its secretion or musculature, either directly or reflexly, through their nervous mechanism. These drugs are classified into **Bitters, Digestives, Purgatives, Astringents** and **Carminatives.**

VEGETABLE BITTERS

Calumba, Quassia, Gentian, Orange Peel, Serpentary.

General Remarks.—Bitters are substances containing a bitter principle which reflexly stimulates the functions of the stomach. They have very little in common beyond the bitter taste and absence of absorptive action. Bitters are divided into *simple bitters*, containing only a bitter principle, *e.g.*, Calumba, Quassia; and *aromatic bitters* containing in addition to the bitter principle, a small quantity of volatile oil which materially aids their stimulation, *e.g.*, Gentian and Orange Peel. There are other drugs besides these which have a bitter taste, such are all alkaloids, and cinchona, but they have a wider sphere of action and as such, are described elsewhere.

CALUMBA

Calumba. *Synonym.*—Calumba Radix. Calumba Root. Dried transversely cut slices of the root of *Jateorhiza Calumba.* Odour slight; taste slightly aromatic and bitter. It contains three crystalline alkaloids, a bitter crystalline principle, *calumbamine*, and a large quantity of starch. It contains no tannin; so it can be prescribed with iron salts.

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Infusum Calumbæ Recens.**—5 per cent. in cold water to avoid extraction of starch.

   Dose—½ to 1 fl. oz.—15 to 30 mils.

2. **Infusum Calumbæ Concentratum.**—Prepared by exhausting 400 grammes of pieces of calumba in alcohol (25 per cent.) and adding distilled water in sufficient quantity.

   Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Tinctura Calumbæ.**—10 per cent. in alcohol (60 per cent.)

   Dose—½ to 1 fl. dr.—2 to 4 mils.

QUASSIA

Quassia. *Synonym.*—Quassia Lignum. The wood of the trunk and branches of *Picræna Excelsa.*—It occurs in logs, chips or raspings having yellowish white colour. Inodorous; with an intensely bitter taste. It contains a crystallizable bitter principle *quassin*, slightly soluble in water, but easily in alcohol and hot water. It contains no tannin.

1. **Infusum Quassiæ Recens.**—1 per cent. solution in cold water to avoid excessive extraction of the bitter principle.

Dose—½ to 1 fl. oz.—15 to 30 mils.

2. **Infusum Quassiæ Concentratum.**—Prepared by exhausting 80 grammes of quassia chips in alcohol (25 per cent.) and adding distilled water in sufficient quantity.

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Tinctura Quassiæ.**—10 per cent. solution in alcohol (45 per cent.)

Dose—½ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Quassiæ Concentrata.**—It has approximately four times the strength of Tincture of Quassia.

Dose—8 to 15 ms.—0·5 to 1 mil.

GENTIAN

Gentiana. *Synonym.*—Gentianæ Radix. The dried Rhizome and roots of *Gentiana Lutea.* Odour strong and characteristic; taste first sweet and then bitter. It contains a bitter glucoside *genitopicrin*, a trace of *volatile oil*, gum and sugar. It contains no starch, nor tannin; yet it cannot be prescribed with iron which darkens the colouring matter.

1. **Extractum Gentianæ.**—A soft aqueous extract.

Dose—2 to 8 grs.—0·12 to 0·5 G.

2. **Infusum Gentianæ Compositum Recens.**—1·25 per cent. with bitter orange and lemon peels.

Dose—½ to 1 fl. oz.—15 to 30 mils.

3. **Infusum Gentianæ Compositum Concentratum.**

Dose—½ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Gentianæ Compositus.**—10 per cent. of gentian with bitter orange peel and cardamoms in alcohol (45 per cent.)

[illegible]

5. Tinctura Gentianæ Composita Concentrata.—It has approximately four times the strength of Compound Tincture of Gentian.

Dose—8 to 15 ms.—0·5 to 1 mil.

ORANGE PEEL

Aurantii Cortex Recens.—Fresh bitter orange peel. The fresh outer part of the pericarp of *Citrus Aurantium.* The odour is pleasant aromatic; taste aromatic and bitter.

1. Tinctura Aurantii Concentrata.—It has approximately four times the strength of Tincture of Orange.

Dose—8 to 15 ms.—0·5 to 1 mil.

2. Tincture Aurantii.—25 per cent., in alcohol (90 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. Syrupus Aurantii.—1·25 per cent. of Tincture of Orange in syrup.

Dose—½ to 1 fl. dr.—2 to 4 mils.

Aurantii Cortex Siccatus.—Dried Bitter Orange Peel. It contains a volatile oil and an amorphous bitter glucoside *Aurantiamarin* and a crystalline glucoside, *hesperidin.*

1. Infusum Aurantii Recens.—5 per cent. in boiling water.

Dose—½ to 1 fl. oz.—15 to 30 mils.

2. Infusum Aurantii Concentratum.

Dose—½ to 1 fl. dr.—2 to 4 mils.

Dried bitter orange peel is contained in Tinctura Cinchona Composita, Infusum Gentianæ Compositum, and Tinctura Gentianæ Composita.

LEMON

Limonis Cortex.—Lemon Peel. The fresh outer part of the pericarp of the fruit of *Citrus Limonia.* It occurs in pale yellow pieces roughened on the outer surface from the presence of oil glands beneath the epidermis. It has a fragrant odour and aromatic bitter taste. It contains the official *volatile oil.*

> 1. **Syrupus Limonis.**—50 per cent. of Lime Juice flavoured with lemon peel in syrup and preserved with alcohol (90 per cent.).
>
> **Dose—½ to 1 fl. dr.—2 to 4 mils.**
>
> 2. **Tinctura Limonis.**—25 per cent. in alcohol (90 per cent.)
>
> **Dose—½ to 1 fl. dr.—2 to 4 mils.**
>
> 3. **Tinctura Limonis Concentrata.**—It has approximately four times the strength of Tincture of Lemon.
>
> **Dose—8 to 15 ms.—0·5 to 1 mil.**

Oleum Limonis.—A volatile oil obtained by expression from fresh lemon peel. It occurs in pale yellow colour with an odour of lemons and a bitter aromatic taste. It is a mixture of *terpenes* and *aldehydes.*

Dose—1 to 3 ms.—0·03 to 0·18 mil.

SERPENTARY

Serpentaria. *Synonym.*—Serpentariæ Rhizoma. The dried Rhizome and roots of *Aristolochia Reticulata*, and is known in commerce as Texan Serpentary. It is of a dull yellowish brown colour, with an aromatic and camphoraceous odour. The taste is bitter aromatic and camphoraceous. It contains a bitter principle *aristolochin*, a *volatile oil* and a *resin.* The official importance of the drug is due to its being in the composition of Tinctura Cinchona Composita. (Vide Supra.)

ACTION AND THERAPEUTIC USES OF BITTERS

External.—Bitters are said to be mild antiseptics and disinfectants, but they are rarely used for this purpose.

Internal.—*Alimentary Tract.*—In the mouth, bitters by stimulating the gustatory nerves increase the secretion of saliva and of the gastric juice by reflex action. In the stomach, their immediate effect is to lessen the secretion of the gastric juice ; but the secretion is considerably increased after an interval of about half an hour. The increased secretion excites appetite. This explains the rationale of giving bitters half an hour before meals. The mechanism of this increase in secretion is not definitely known, but it is partly reflex in origin, as shown by experiments on dogs with œsophageal fistula which prevents substances given by the mouth from reaching the stomach to have any action there. Large doses of bitters, as well as their continuous administration, cause irritation of the stomach and induce gastric catarrh, which diminishes the gastric secretion and may even cause vomiting and diarrhœa. The secretion is also diminished by exhausting the reflex mechanism. Simple bitters have very little action on the motility of the stomach ; but aromatic bitters may act as carminatives by relieving the gripping pain of hunger contractions. In the intestines bitters have no marked action. They increase the secretion of the pancreas indirectly by increasing the gastric juice. Bitters, therefore, act as **stomachics** and **general tonics** by improving digestion.

Blood.—Bitters have no action after absorption ; but they cause a temporary increase in the number of white blood corpuscles in the peripheral circulation.

Precautions.—The administration of bitters should be avoided in all inflammatory conditions of the stomach and they should not be given in the form of a pill or tablet as their bitter taste would not be felt to excite the reflex action necessary to increase the secretion of the gastric juice. They should be administered half an hour before meal to ensure their full effect. Preparations of quassia and calumba alone are compatible with iron as they contain no tannic acid.

Certain bitters, in addition to this their general action, have a special action of their own. **Quassia when administered rectally** as an **infusion** acts as an **anthelmintic** for **thread worms.**

The action and uses of Lemon Peel are the same as those of Orange, the only difference being in the flavour. It is a rubefacient externally.

Fresh lime juice is used mainly as an internal refrigerant to relieve the febrile thirst. It is of special benefit in scurvy, as it contains a vitamin (water soluble C), the deficiency of which in the food causes this disease. It is excreted as carbonate and it diminishes the acidity of urine.

DIGESTIVES

Pepsin and Pancreatin

PEPSIN

Pepsinum.—A proteolytic enzyme, obtained from the mucous membrane of the fresh and healthy stomach of a pig, sheep or calf. It occurs as a yellow-brown powder, or in lustrous pale-yellow translucent scales, with a faint odour and slightly acid and saline taste. It is freely soluble in water, the solution being more or less opalescent. It is a proteolytic ferment, acting chemically in an acid medium, and digests no less than 2500 times its own weight of freshly coagulated and disintegrated egg albumin in about 6 hours, at a temperature of 41° C.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION AND THERAPEUTIC USES

The sole action of pepsin is to convert proteins into soluble and easily absorbable peptones by successive stages of their conversion into acid albumins, primary proteoses and secondary proteoses. It acts best in an acid media, and hence it is always prescribed in combination with hydrochloric acid, the natural acid of the gastric juice. It is given as an aid to digestion when there is deficiency of it in the gastric juice due to the atrophy of the glands as in old age, anæmia, and general debility. It should however, be used as a temporary measure, as its continued use tends to impair the physiologic activity of the gastric juice. The best preparation to administer is the glycerine of pepsin, since it contains also the hydrochloric acid in proper dilution and dose. Combined with bismuth, it is used as a gastric sedative and intestinal astringent in the treatment of sprue, and hill diarrhœa of children. Pepsin is sometimes used to predigest albuminous foods when the condition of the patient necessitates their administration in the form of nutrient enemata, as the rectal mucous membrane has very little power of digestion. Pancreatic extracts are, however, better for this purpose.

PANCREATIN

Pancreatinum.—It is a preparation of the pancreas obtained from certain animals commonly employed for food, by extraction with alcohol (25 per cent.). It contains enzymes, trypsin, amylase and lipase. It occurs as a colourless or buff-coloured amorphous powder, with a meaty odour.

Dose—3 to 10 grs.—0·2 to 0·6 G.

Action and Therapeutic Uses

Pancreas is the most eligible agent for the predigestion of food. About 2½ grs. of powdered pancreas and 7½ grs. of bicarbonate of soda will digest about ½ a pint of milk administered by the mouth. Its activity is destroyed by the hydrochloric acid of the stomach. To be effective in the intestine for certain types of indigestion, it is best administered in enteric capsules, which do not dissolve until they reach the alkaline contents of the intestine.

PURGATIVES

(*a*) **Laxatives.**—Tamarinds Agar-Agar, Cassia, Castor Oil, Phenolphthalein.

(*b*) **Simple Purgatives.**—The anthracene group.—Rhubarb, Senna, Cascara Sagrada, Aloes.

(*c*) **Drastic and Hydragogue Purgatives.**—Jalap, Scammony, Colocynth.

(*d*) **Cholagogues.**—Podophyllum, Ox. bile.

LAXATIVES

TAMARINDS

Tamarindus.—The fruit of *Tamarindus Indica* freed from the brittle outer pericarp and preserved with sugar. A reddish brown mass with an agreeable sub-acid taste. It contains *tartaric acid, acid potassium tartrate, cane sugar,* and other acids.

Tamarind is contained in Confectio Sennæ.

ACTION AND THERAPEUTIC USES

Tamarind is rarely given alone as a laxative. It is given as a refrigerating drink in fevers. It acts as a laxative mechanically by increasing its bulk as a result of absorption of water from the intestine and also by delaying the absorption of the intestinal fluid owing to the formation of alkaline tartrates in the bowel by the tartaric acid contained in it.

AGAR

Agar. *Synonym.*—Agar-Agar. It is a dried gelatinous substance obtained from *Gelidium Corneum Lamouroux, Gelidium Cartilagineum* and other closely allied algæ (flowerless aquatic plants) of the class Rhodophyceæ. It occurs in slender translucent, lustrous strips about 4 to 6 millimeters in length, or yellowish bands about 4 centimetres wide or greyish white powder. It swells in water to a gelatinous mass. It is insoluble in cold water, but soluble in 100 parts of boiling water, the solution forming a jelly when cooled,

Dose—60 to 240 grs.—4 to 16 G.

ACTION AND THERAPEUTIC USES

Agar is chiefly used as a laxative acting mechanically by absorbing moisture and increasing the bulk of intestinal contents which distend the bowels and stimulate peristalsis. It is often associated with a mineral oil but other purgatives may be incorporated with it, if deemed necessary. Agar jelly has very little purgative action, as it does not swell in the intestine like crude agar. It is, however, largely used for preparing bacteriological culture-media for the growth of micro-organisms, as the high melting point (40°) of the jelly renders it particularly suitable for this purpose.

CASSIA

Cassia. *Synonym.*—Cassiæ Pulp. It is the pulp of the fruit, obtained by percolating the crushed pods of *Cassia Fistula* with distilled water, then straining and evaporating to the consistency of a soft extract. It is used as a **laxative.** It contains an active principle chemically related to the *cathartic acid* of senna, sugar and traces of *anthraquinone.*

Dose—60 to 120 grs.—4 to 8 G.

ACTION AND THERAPEUTIC USES

It is a laxative, only used in Confection of Senna

CASTOR OIL

Oleum Ricini.—A fixed oil obtained from the seeds of *Ricinus Communis.* It is of a pale yellow colour having a faint mild odour. The taste is generally nauseating. It is soluble in absolute alcohol and 1 in 3·5 of alcohol (90 per cent.) It contains *ricinoleate of glyceril* and other fixed oils.

Dose—1 to 4 fl. drs—4 to 16 mils.

Seeds of castor oil contain a powerful poison *ricin*, which renders their use medicinally impossible.

Castor Oil is contained in Collodium Flexile.

ACTION OF CASTOR OIL

External.—Pure castor oil, having no free fatty acids in its composition, is bland and unirritating. It is, therefore, employed as a local sedative and protective. It is used even as a demulcent in conjunctival irritation. Applied locally to the breast, it acts as a **galactagogue.**

Internal.—*Alimentary Tract.*—Medicinal doses of pure castor oil have no action on the stomach; but if impure or rancid may cause nausea and vomiting. The chief action of castor oil is on the intestines. Having passed unchanged into the duodenum, it is saponified by the bile and is acted upon by the lipase—the fat splitting ferment of the pancreas—to be split up into its component parts, ricinoleic acid and glycerine. Ricinoleic acid, acting as an irritant to the intestinal mucous membrane, stimulates reflex peristalsis through the irritation of the nerve endings in it and drives the fluid contents of the intestines into the colon. The distension of the colon allays its normal antiperistalsis, and purgation results in from 3 to 8 hours according to the dose.

Absorption and Elimination.—Ricinoleic acid enters the blood and tissues and is removed by all secretions, including the secretion of the milk, and in this way causes purgation in the breast-fed infants.

Administration.—The chief drawback of castor oil is its disagreeable smell and taste. The taste may be disguised by giving it in coffee, orange juice, brandy or any aromatic water. It may be administered in the form of an emulsion. To be effective, it should be given on an empty stomach, as food retards its action. Children bear large doses of castor oil out of proportion to their age.

THERAPEUTIC USES

Castor oil is the safest of the purgatives and is administered in cases where violent purgatives are contra-indicated as in the cases of infants and the aged, during pregnancy and in acute abdominal diseases. It is especially employed in cases of diarrhœa due to the presence of some irritant material in the intestines. It is used in small doses in cases of colitis where it is generally combined with small doses of opium ; administered per rectum, castor oil acts also as an aperient and when added to enemata it enhances the effect.

PHENOLPHTHALEIN

1. **Phenolphthaleinum.**—Phenolphthalein. *Synonyms.*—Purgen, Laxoin, Laxatol, Dihydroxy-diphenyl-phthalide. Occurs as a white or faintly yellowish white crystalline or amorphous powder, odourless, tasteless and almost insoluble in water but soluble in solutions of alkaline hydroxides.

Dose—1 to 5 grs.—0·06 to 0·3 G. Best given in cachets or lozenges.

ACTION AND THERAPEUTIC USES

Phenolphthalein is a mild, tasteless **purgative,** acting mainly by its mild irritant action, which stimulates peristalsis and increases the secretion of the intestines. It acts chiefly on the large intestines and takes about 6 to 8 hours to act. After reaching the large intestine, a part of it is reabsorbed to be thrown again into the intestines with bile, to act again as a purgative. The laxative effect may thus be continued for several days. It is also partly excreted by the urine giving it, if alkaline, a pink colour. It may, in some cases, cause renal irritation or eruptions to appear on the skin lasting for some days. Under various names it is exploited as a proprietary medicine.

SIMPLE OR ANTHRACENE PURGATIVES

RHUBARB

Rheum. *Synonym.*—Rhei Rhizoma, Rhubarb. The rhizome of ***Rheum Palmatum,*** occurs as irregularly shaped piece having a peculiar aromatic odour, and a bitter astringent taste. It contains *chrysarobin*, *chrysophanic* acid and *emodin*. These are all derivatives of anthraquinone. In addition, it contains *rheo-tannic acid* and oxalate of lime.

Dose—3 to 15 grs.—0·3 to 1 G.

1. **Pilula Rhei Composita.**—It is a pill mass made up with hard soap, glucose, scented with oil of peppermint and contains rhubarb, aloes and myrrh.

Dose—4 to 8 grs.—0·25 to 0·5 G.

2. **Pulvis Rhei Compositus.** *Synonym.*—Gregory's Powder. Contains rhubarb, light and heavy magnesium carbonates and ginger.

Dose—10 to 60 grs.—0·6 to 4 G.

3. **Tinctura Rhei Compositus.**—Contains 10 per cent. of rhubarb, flavoured with cardamoms and coriander, in alcohol (45 per cent.).

Dose—½ to 1 fl. drm.—2 to 4 mils.

SENNA

Sennæ Folia.—Senna leaves. The leaflets of *Cassia Acutifolia* or *Angustifolia*. Pale green leaves having a characteristic odour; taste mucilagenous and slightly bitter. It contains a *cathartic acid*, which is a mixture of senna-*emodin*, senna-*chrysophanic acid* and other *anthraquinone* derivatives.

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Confectio Sennæ.**—Contains 10 per cent. of senna leaves with other laxatives such as figs, tamarind, cassia pulp.

Dose—60 to 120 grs.—4 to 8 G.

2. **Pulvis Glycyrrhizæ Composita.**—Contains 16 per cent. of senna with 8 per cent. of sulphur.

Dose—60 to 120 grs.—4 to 8 G.

Sennæ Fructus.—Senna Fruit. *Synonym.*—Senna Pod. The dried ripe fruits of *Cassia Acutifolia* and of *Angustifolia*. These are flat thin, broadly oblong or somewhat reniform ounded at the apex. Pericarp dry and membranous. Con-ains about 6 flattened seeds.

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Extractum Sennæ Liquidum.**—It is an extract made with chloroform water and preserved with 25 per cent. of alcohol.

Dose—10 to 30 ms.—0·6 to 2 mils.

2. **Infusum Sennæ Recens.**—10 per cent. with ginger in boiling water.

Dose—½ to 2 fl. ozs.—15 to 60 mils.

3. **Infusum Sennæ Concentratum.**

Dose—30 to 60 ms.—2 to 4 mils.

4. **Mistura Sennæ Composita.** *Synonym.*—Black draught. Contains 25 per cent. of magnesium sulphate in fresh infusion of senna with aromatics and liquid extract of liquorice, which gives a black colour to the mixture, and hence the name.

Dose—1 to 2 fl. ozs.—30 to 60 mils.

5. **Syrupus Sennæ.**—Contains 2·5 per cent. with oil of coriander in syrup.

Dose—½ to 2 fl. drs.—2 to 8 mils.

CASCARA SAGRADA

Cascara Sagrada.—The dried bark of the trunk and ranches of *Rhamnus Purshianus*, stored at least one year efore use. Odour distinct; taste bitter and slightly acid. ontains *cascarin*, an emodin principle; several *resins* and *olatile oils.*

1. **Extractum Cascara Sagradæ Siccum.**—A watery extract evaporated to dryness.

Dose—2 to 8 grs.—0·12 to 0·5 G.

2. **Extractum Cascara Sagradæ Liquidum.**—An alcoholic and a queous extract.

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Elixir Cascara Sagradæ.**—Contains cascara sagrada, liquorice, light magnesium oxide and aromatic oils; preserved with alcohol and glycerine.

Dose—½ to 2 fl. drs.—2 to 8 mils.

ALOES

Aloe.—The inspissated juice of the leaves of *Aloe Chinensis*, *Aloe Perryi*, and other species. It occurs as brown opaque glassy masses having aromatic odour, and nauseous bitter taste. It is partly soluble in cold water; and completely soluble in alcohol. It contains *Aloin*, and *Emodin* with traces of gallic acid and *volatile oils*.

Dose—2 to 5 grs.—0·12 to 0·3 G.

1. **Pilula Aloes.**—58 per cent. with soap and caraway oil.

Dose—4 to 8 grs.—0·25 to 0·5 G.

2. **Pilula Aloes et Asafetida.**—20 per cent. each of aloes, asafetida and soap.

Dose—4 to 8 grs.—0·25 to 0·5 G.

3. **Pilula Aloes et Ferri.**—20 per cent. of aloes and 10 per cent. of exsiccated ferri sulphate.

Dose—4 to 8 grs.—0·25 to 0·5 G.

Aloes is contained in Pilula Colocynthidis et Hyoscyami, Pilula Rhei Composita and Extractum Colocynthidis Compositum.

Aloin.—It is a crystalline active principle of Aloes; yellow in colour, having an odour of aloes and intensely bitter in taste. It is soluble in water and alcohol.

Dose—¼ to 1 gr.—0·015 to 0·6 G.

ACTION OF SIMPLE OR ANTHRACENE PURGATIVES

The action of rhubarb, aloes, senna and cascara sagrada may be taken together, because each of them owes its action to the active principles which are derivatives of anthracene. They all contain emodin (tri-oxy-methyl-anthraquinone), and some of them contain, in addition, chrysophanic acid (dioxymethyl-anthraquinone).

Alimentary Tract.—Aloes, cascara sagrada and rhubarb in small doses act as **stomachics,** They have very little action on the small intestine, but they exert a selective action on the large intestine. As they take some time to reach there, they are slow in their action, and take about 8 to 12 hours to produce purgation, except Aloes, which takes about 10 to 15 hours owing to the very slow decomposition of its active principle aloin to anthraquinone derivatives. The anthraquinone derivatives in these simple purgatives irritate the colon, cause hyperæmia of the mucous membrane, and reflexly stimulate the muscular coat of the colon to cause brisk peristaltic action accompanied by griping. The contents received from the small intestine are, therefore, not allowed to stagnate to absorb water but are hurried along to cause loose watery evacuation. It is said that they even allay the normal antiperistalsis of the colon and increase local defecation reflex.

Absorption and Elimination.—During the passage of these purgatives through the small intestine, a portion of the anthraquinone derivative (chrysophanic acid) gets absorbed into the system and is excreted by the large intestines, kidneys and milk. During its excretion through the large bowels, it keeps up the local irritation caused by these drugs, and may act as purgative till the whole of it is excreted out of the system. There is no after constipating effect in the case of these purgatives, except in the case of rhubarb. The excretion into the colon of rheotannic acid being in its composition proportionately larger than the anthraquinone derivative, causes constipation. The excretion of chrysophanic acid by the kidneys causes yellow discolouration of the urine if it is acid, and reddish if it is alkaline. The appearance of chrysophanic acid in milk causes purgation in breast-fed infants.

Side-actions.—The hyperæmia of the large bowels induced by these purgatives may cause reflex congestion of the pelvic viscera and may lead to hæmorrhoids, excessive menstruation and even abortion. These effects are particularly marked in the case of senna and aloes, if they are used daily to relieve habitual constipation.

THERAPEUTIC USES

Rhubarb in the form of pulvis Rhei Co. is largely employed in derangements of the gastro-intestinal tract in children. Owing to its slight astringent after effect, it is a useful remedy in the summer diarrhœa of children and in any diarrhœa which is caused and maintained by any indigestible irritant in the bowel.

Senna in the form of compound liquorice powder is largely used as a habitual laxative in constipation due to hæmorrhoids and fissure of the anus. It causes a soft and easy stool without much griping. For chronic constipation the chewing of 20 to 30 senna leaves every day ensures daily evacuation without griping. An infusion of Senna made by keeping 6 or 8 pods over night in cold water and taken early in the morning is also useful in relieving constipation. As an occasional purgative and to complete the effects of mercury and other duodenal purgatives taken some hours before, senna in the form of black draught is an effective purge.

Cascara Sagrada is a remedy of choice in habitual constipation. By its gentle stimulation of the intestinal tract, it tones the intestines to cause soft and easy stool. The continued use of cascara does not establish tolerance for the drug ; on the contrary, when the habit of daily evacuation is established the dose may be gradually reduced to give it up entirely later on.

Aloes as a purgative is indicated in constipation from atony of the colon associated with dyspepsia or anæmia. There are suitable pills of aloes to relieve constipation associated with particular complaints. These pills, however, should be cautiously used, as aloes in them causes congestion of the sigmoid colon and rectum and may lead to hæmorrhoids. The local congestion extends to the pelvic organs, and hence it acts as an **emmenagogue** and may even lead to excessive menstruation. It should be avoided during pregnancy as it may even cause abortion. In the form of an enema, Aloes is used as an **anthelmintic** for thread-worms.

DRASTIC HYDRAGOGUE AND PURGATIVES

JALAP

Jalapa.—Resinous, dark brown tuberous roots of *Ipomœapurga* having a characteristic odour and a sweet acrid taste. It should contain 9 to 11 per cent. of *resin*.

1. **Jalapa Pulverata.**—Powdered Jalap.

Dose—5 to 20 grs.—0·3 to 1·2 G.

2. **Pulvis Jalapæ Compositus.**—Contains Jalap, Acid potassium tartrate flavoured with ginger.

Dose—10 to 60 grs.—0·6 to 4 G.

SCAMMONY RESIN

Scammoniæ Resin.—Resin of Scammony. *Synonym.*—Resin of Ipomœa. It is a mixture of resins obtained from *Ipomœa.* It occurs as brown brittle translucent pieces with a fragrant odour; and is soluble in alcohol and in alkaline aqueous solutions.

Dose—½ to 3 grs.—0·03 to 0·2 G.

It is contained in all the preparations of Colocynth. (Vide Infra.)

COLOCYNTH

Colocynthis. *Synonyms.*—Colocynthidis Pulpa; Bitter apple; Bitter Calumba. The dried pulp of the fruit of *Citrullus Colocynthis* freed from seeds. It contains a bitter resinous matter *colocynthin* and an *amorphous alkaloid.*

Dose—2 to 5 grs.—0·12 to 0·3 G.

1. **Extractum Colocynthidis Compositum.**—Contains colocynth, aloes, and scammony.

Dose—2 to 8 grs.—0·12 to 0·5 G.

2. **Pilula Colocynthidis Hyoscyami.**—A pill mass containing compound colocynth extract and extract of hyoscyamus.

Dose—4 to 8 grs.—0·25 to 0·5 G.

ACTION OF DRASTIC PURGATIVES

External.—They are irritant to the skin and mucous membranes but they are not used for this purpose.

Internal.—*Alimentary Tract.*—The activity of these purgatives depends on the solubility of the resinous principles found in their composition. In the mouth, the secretion of saliva dissolves a portion of them and excites bitter taste, which reflexly increases the secretion of saliva. In the stomach, the resinous matter remains inert as it is not dissolved by the gastric juice. In the intestines, these drugs exert their chief action and act as purgatives producing watery stools accompanied by severe griping. In the duodenum, the bile, the outpouring of which is increased by them, dissolves an effective quantity of these resinous principles to form a strong purgative compound which acts as an irritant to the whole of the intestinal tract. The irritant effect is not restricted to the large intestine as in anthracene purgatives. The irritation of the small intestine increases its secretion and starts a vigorous peristaltic action which is generally accompanied by severe griping. The fluid contents of the small intestine are quickly propelled into the large intestine and are rendered still more fluid by the increased secretion of the mucous membrane there, and probably also by inhibition of its normal antiperistalsis The contents of the intestines are ultimately thrown out as continuous watery stools within about 2 to 4 hours of their administration. In the absence of bile, these purgatives have very little effect, as is seen in obstructive jaundice.

In large doses, they cause severe inflammation of the gastro-intestinal tract, with profuse vomiting and diarrhœa and associated symptoms of collapse: feeble pulse, cold sweats, pale skin, and great muscular relaxation. They may also give rise to renal irritation.

Jalap is a powerful hydragogue purgative stimulating largely the secretion of the small intestine and the peristaltic movement of the large intestine. It may be given as a vermifuge.

Scammony acts like jalap, but is more drastic. It is an **anthelmintic** to both round worms and tape worms.

Colocynth is a typical cathartic causing severe griping pain as well as a copious increase in the intestinal secretion. It is therefore both a **hydragogue** and a **cathartic** purgative.

THERAPEUTIC USES

Hydragogue purgatives are largely used to drain fluid from the system, as in cases of dropsical effusions, especially in the large serous cavities. Compound jalap powder is quite effective for this purpose. They are also used to relieve the kidneys in nephritis, to lower temperature in fevers, to relieve cerebral congestion, to lower blood pressure and in severe cases of constipation.

CHOLAGOGUES

These are all resinous purgatives but separated from the group of drastic purgatives, as they are slow in action and stimulate the liver with a decided increase in the flow of bile.

PODOPHYLLUM

Podophyllum. *Synonym.*—Podophylli Rhizoma. Dried rhizome and roots of *Podophyllum peltatum.* It contains the official *resin* which is the purgative principle and the alkaloid *berberine.*

Dose—2 to 10 grs.—0·12 to 0·6 G.

Podophyllum Indicum. *Synonym.*—Podophylli Indici Rhizoma. Dried rhizome and roots of *Podophyllum emodi.*

Dose—2 to 10 grs.—0·12 to 0·6 G.

Podophylli Resina. *Synonyms.*—Podophyllum Resin ; Podophyllin. It is a mixture of resins, obtained from Podophyllum or from Indian Podophyllum. It occurs in pale yellow, yellow, or yellowish brown, amorphous powder, or in Grey brownish masses. It is insoluble in water, but completely soluble in alcohol (90 per cent.) and in alkaline solutions.

Dose—¼ to 1 gr.—0·015 to 0·06 G.

ACTION AND THERAPEUTIC USES OF CHOLAGOGUES

Podophyllum in large doses acts as a cathartic with cholagogue properties. It is absorbed from the broken skin and when given hypodermically it produces the same cathartic effect as when given by the mouth. Its resin is a slowly acting but powerful and certain cathartic, producing several watery stools, which contain large amounts of bile. In therapeutic doses, it is believed to increase the salts of bile without affecting its secretion. It is, therefore, largely used in the treatment of constipation with hepatic torpor. For this purpose, it is given in frequently repeated doses combined with belladonna or hyoscyamus to counteract its griping tendencies. In large doses, it acts as a gastro-intestinal irritant.

OX BILE

Extractum Fellis Bovini. *Synonym.*—Fel Bovinum Purificatum. Purified Ox Bile. It occurs as a brownish-green or dark-green, viscid liquid, having a characteristic odour and a sweetish bitter taste. It contains *glycocholic* and *taurocholic acids, cholestrine* and *pigments.*

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

Bile taken by the mouth increases the secretion of bile by the liver. It is the only substance which acts as a **true cholagogue.** It stimulates the peristaltic action of the intestine and acts as a laxative; at the same time, it assists in the digestion of fats. It is, therefore, used as a **laxative** in chronic constipation and in faulty absorption of fat due to its defective digestion in the duodenum. It also acts as an **intestinal antiseptic.** In the form of an enema, it is useful in cases of impacted fæces and acts by lowering the surface tension. It is best given 1 and 2 hours after meals, when the gastric contents are passing through the pylorus.

VEGETABLE ASTRINGENTS

TANNINS

Tannic Acid, Catechu, Krameria, Hamamelis.

Acidum Tannicum.—Tannic Acid. *Synonyms.*—Tannin, Digallic Acid. It occurs as a pale yellow powder, containing glistening scales, having a strongly astringent taste. It is readily soluble in water and alcohol.

Incompatibles.—Iron salts, mineral acids, salts of lead, silver, arsenic, antimony, gelatin, alkalies and alkaloids.

Dose—5 to 10 grs.—0·3 to 0·6 G. (rarely given internally).

1. **Glycerinum Acidi Tannici.**—15 per cent. in glycerine.

Dose—10 to 30 ms.—0·6 to 2 mils.

2. **Pasta Acidi Tannici.** *Synonym.*—Tannic Acid Jelly. Tannic acid 5 per cent., tragacanth 2 per cent., chlorocresol 1 per cent., Alcohol (95 per cent.) 6 per cent.

3. **Suppositorium Acidi Tannici.**—Each containing 3 grs. of tannic acid.

4. **Trochiscus Acidi Tannici.**—Each containing ½ gr.

5. **Unguentum Acidi Tannici.**—1 in 5 with glycerine in a basis of yellow beeswax and benzoated lard or a basis of simple ointment, prepared with yellow soft paraffin.

Catechu. *Synonyms.*—Gambir, Pale Catechu. A dried extract of the leaves and young shoots of *Uncaria gambir.* It occurs in deep reddish brown cubes, having an astringent taste. It is entirely soluble in boiling water. It contains about 40 per cent. of *catechu-tannic acid*, the active principle, and a crystalline bitter substance *catechin.*

Dose—5 to 15 grs.—0·3 to 1 G.

Tinctura Catechu.—20 per cent. with cinnamon in alcohol (45 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

Hamamelis. *Synonyms.*—Hamamelidis Folia, Witch Hazel. Leaves. The dried leaves of *Hamamelis Virginiana.* It contains about 5 per cent. of *tannin.*

Extractum Hamamelidis Liquidum.—An alcoholic extract, obtained by exhausting 50 per cent. of powdered leaves in alcohol (45 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

Unguentum Hamamelidis.—The liquid extract, 1; wool fact, 5; soft paraffin, 4.

Krameria. *Synonyms.*—Krameriæ Radix. Rhatany Root. Purplish brown woody branching root of *Krameria triandra.* It contains about 10 per cent. of *Krameria tannic acid.*

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Extractum Krameriæ Siccum.**—An aqueous dry extract.

Dose—5 to 15 grs.—0·3 to 1 G.

2. **Tinctura Krameriæ.**—20 per cent. in alcohol (60 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Trochiscus Krameriæ.**—Contains 1 gr. of the extract of Krameria in each with a fruit basis.

4. **Trochiscus Krameriæ et Cocainæ.**—Contains $\frac{1}{20}$ gr. of cocaine hydrochloride.

ACTION OF VEGETABLE ASTRINGENTS

External.—The vegetable astringents owe their action to the tannin in their composition, and though the tannins in different crude drugs vary in their chemical constitution, yet their pharmacological action is the same. There are, however, slight differences of action between them, due to their solubility in water and the readiness with which they yield tannic acid. The action of pure tannic acid will be described first.

The chief action of tannic acid is to constrict the blood vessels and to coagulate the proteins of the tissues with which it comes into contact. The coagulum so formed is insoluble in water, weak acids or alkalis, and resists the action of bacteria. It thus acts, to some extent, as an **antiseptic.** Applied to raw or mucous surfaces, it coagulates the protein of the discharge which acts as a protective covering to the tissues underneath, and it soaks into the tissues to hinder further discharges by coagulating the albumen there. It, therefore, acts as an **astringent.** When applied to bleeding surfaces, it precipitates the proteins of blood, and favours clotting. It thus acts as a **local hæmostatic.** In concentrated solution it acts as a caustic by causing death of the cells by precipitating the vital protoplasm.

Internal.—*Alimentary Tract.*—In the mouth, the dissolved drug finds its way through the excretory ducts into the mucous glands and stops their secretion. Consequently, the mouth becomes dry and a feeling of thirst is produced. In the stomach, tannic acid interferes with the digestion by combining with the proteins of the food, but is liberated again in the process of their digestion and the liberated tannic acid exerts no further action on the food in an acid medium. In the absence of food, tannic acid acts as an **astringent** on the walls of the stomach, diminishes its secretion and checks **gastric hæmorrhage.** In the intestine, it has hardly any action as it is converted by the alkaline juices of the intestines into gallic acid and alkaline tannates, which have very little astringent action. If, however, some of the tannic acid escapes this conversion, which is possible with large doses of tannic acid, it dries the secretion of the intestine which forms a protective surface to prevent reflex peristaltic action. There is re-absorption of water from the stagnated contents of the intestine, which results in constipation with hard fæcal masses. Tannic acid precipitates most of the alkaloids, and is therefore used as an **antidote in alkaloidal poisoning.**

Absorption and Elimination.—The gallic acid and the alkaline tannates formed in the intestines leave the body with fæces but a portion of it circulates in the blood as such, and is partly excreted in the urine and partly destroyed in the body. As tannic acid is absorbed as a non-astringent compound, it has no remote astringent effect, nor does it act as a remote hæmostatic.

Tannic acid, owing to its powerful astringent effect on the stomach and practically having no astringent effect on the intestines, it is not given internally as an astringent; but to obtain that effect on the alimentary tract, crude drugs containing it, particularly catechu and krameria, are largely used. They are not absorbed from the stomach, but reach the intestines to liberate tannic acid slowly during the process of digestion. For producing the necessary astringent effect over a prolonged period low down in the intestines, bael fruit and myrobalans are mainly used in India and the Eastern Colonies of the Empire. Hamamelis is used externally as a hæmostatic and astringent. It is credited with remote astringent effects, but this action is doubtful.

Metallic v/s. Vegetable astringents.—All soluble salts of heavy metals, act only as astringents in all concentrations. The metal of the metallic salts combines with the proteins of the tissues to form more or less difficultly soluble precipitate and liberate acid to produce an irritant action there. In the case of vegetable astringents the tannic acid itself of the crude drugs coagulates the proteins, to form an insoluble precipitate. Internally, metallic astringents inhibit the peristalsis by a direct action, while vegetable astringents do the same indirectly, by allaying the underlying inflammation. The slow absorption of the metal from the precipitate produces remote effects and the continued administration of metallic astringents causes cumulation of the metal in the system to produce symptoms of poisoning. None of these effects is seen in vegetable astringents, as the tannic acid of these is absorbed as an innocuous compound.

The only metallic astringent, which resembles vegetable astringent in action, is lead. It forms in the intestine a tough tenacious and very insoluble albuminate of lead to produce a prolonged astringent effect; but its continued administration is to be avoided as it accumulates in the body and produces symptoms of chronic lead poisoning.

THERAPEUTIC USES

For external treatment pure tannic acid is much more used than other vegetable astringents. As an astringent, tannic acid is applied locally, to wounds, ulcers and bleeding surfaces, as dusting powder, ointment or lotion. It is now-a-days very largely used in the treatment of large burns, in solutions of 2 to 5 per cent. The coagulum formed prevents the absorption of the toxins produced by protein destruction, and provides a slough greatly resistant to septic action. It is also used for checking excessive discharge from mucous surfaces as in gonorrhœa, leucorrhœa and ozæna. Lozenges are used in different kinds of mouth and throat diseases, such as spongy gums, relaxed throat, enlarged and inflamed tonsils, elongated uvula, etc. They are given internally in gastric and intestinal hæmorrhages and diarrhœa. Tannic acid is given as an antidote to antimony, and alkaloids, and is followed by a purgative in cases of alkaloidal poisoning.

CARMINATIVES

These are generally substances containing volatile oils which aid **in the expulsion of gas from the stomach and intestines and thus diminish flatulence and colic.** It is therefore convenient to describe these substances here in a separate group of volatile oils.

GROUP VII

VOLATILE OILS

THE ACTION OF VOLATILE OILS IN GENERAL

The physiological action of most of these oils has many features in common, and these will be described here to avoid repetition.

External.—All volatile oils, in varying degrees of intensity, act as **irritants** to the skin, causing redness and vesication, but no destruction of the tissue. They stimulate the sensory nerve endings in the skin to cause a burning sensation, which is followed by numbness. On raw surfaces, they act as **antiseptics** but their usefulness is much limited by their relative insolubility in water.

Internal.—*Alimentary Tract.*—All volatile oils in small doses stimulate and regulate the activity of the gastro-intestinal tract. The secretion of saliva, stomach and intestine is increased and the spasmodic activity of its muscle is regulated. Thus they act as **sialagogues, stomachics** and **carminatives.** In large doses, the oils act as gastro-intestinal irritants, producing vomiting and diarrhœa. There is a reflex stimulation of the heart and central nervous system.

Absorption and Elimination.—Volatile oils, being insoluble in water and in the body juices, are absorbed very slowly when given by injection; but most of them are absorbed with sufficient readiness when administered *per os.* As a rule, the more volatile the oil, the more readily it is absorbed. After absorption, they are partly oxidised in the body and partly excreted unchanged or combined, through the lungs, kidneys and skin.

Blood.—Many of the oils cause increase in the number of leucocytes circulating in the blood, and the increase is more marked when the volatile oils are administered by the mouth. This is probably due to the increased flow of lymph from the abdominal viscera.

Circulatory System.—All volatile oils in medicinal doses slow the heart and increase the strength of its beats. The arterioles are dilated by their direct action on the vessels but the stimulation of the vaso-motor centre counteracts this effect and causes the blood pressure to rise. Large doses make the heart weak and rapid, and the blood pressure falls.

Respiratory System.—In medicinal doses, volatile oils during their elimination from the lungs, stimulate the bronchial mucous membrane, increase its vascularity and secretion which reflexly excite cough by the stimulation of the nerve endings in it. They are, therefore, **expectorants.** In moderately large doses, the respiratory centre is stimulated to increase the depth and frequency of respiration. In large doses, they are directly depressants to the respiratory centre and lead to shallow breathing.

Urinary System.—Volatile oils are excreted, in combination with glycuronic acid by the kidneys, and in small doses they stimulate the renal cells to act as **diuretics**, exerting at the same time their antiseptic action. Many of the oils impart their characteristic odour to the urine. In large doses, they irritate the kidneys and cause albumen and blood to appear in urine. The genito-urinary tract is also irritated and there occurs vesical pain and stranguary due to the inflammation of the bladder.

Skin.—Volatile oils, during their elimination from the skin, stimulate the sweat glands, increase their secretion and act as **diaphoretics** At the points of elimination, they irritate the area of skin and cause rash to appear on the body.

Nervous System.—Volatile oils in therapeutic doses have very little effect on the central nervous system. In large doses they primarily stimulate and subsequently depress the nervous system. The therapeutic doses, however, exert a paralytic action on the sympathetic endings.

Although as indicated, all volatile oils resemble each other in their characteristic action on the body, the relative intensity of each of these effects on a particular tissue of the body differs, to a great extent, from one oil to another, and are used for widely different purposes. They are, therefore, classified as follows :—

Class I.—The rubefacient group.—These are volatile oils, or substances containing them, used chiefly for their stimulating effect on the skin.

Oil of turpentine, Tar, Oil of Cade, Colophony, Oil of Cajuput, Oil of Eucalyptus, Oil of Rosemary and Oil of Lemon.

Class II.—The carminative group.—These are volatile oils, or substances containing them, used chiefly for their stimulating effect on the gastro-intestinal tract.

Cloves, Nutmeg, Cinnamon, Cardamoms, Ginger, Capsicum, Oil of Lavender, Oil of Bitter Almond, Oil of Peppermint, Anise, Coriander, Fennel, Caraway, Dill.

Class III.—The expectorant group..—These are volatile oils or substances containing them, used chiefly for their stimulating effect on bronchial mucous membrane.

Terebene, Balsam Peru, Balsam Tolu, Storax, Oleum Abietis.

Class IV.—The diuretic group..—These are volatile oils or substances containing them, used chiefly for their stimulating effect on the kidneys and genito-urinary tract.

Copaiba, oil of Sandalwood, Buchu.

Class V.—The nervine sedative group.—These are volatile oils or substances containing them, used chiefly for their reflex stimulating effect on the central nervous system.

Valerian, Asafetida, Myrrh.

VOLATILE OILS

Class I

THE RUBEFACIENT GROUP

OIL OF TURPENTINE

Oleum Terebinthinæ. *Synonym.*—Oleum Terebinthinæ Rectificatum; Rectified oil of turpentine. The oil distilled from the oleo-resin, obtained from various species of *Pinus*, and rectified. It is a limpid, colourless oil with a characteristic odour and a somewhat bitter and pungent taste. The oil of turpentine is a mixture of several *isomeric hydrocarbons* which, if oxidised by air, or while in contact with water, are decomposed into *terpene hydrate, hydrogen peroxide* and *camphoric acid.*

Dose—3 to 10 ms.—0·2 to 0·6 mil.

2 to 4 fl. drs.—8 to 16 mils. as anthelmintic.

1. Linimentum Terebinthinæ.—Oil of Turpentine 65 per cent., camphor 5 per cent., soft soap and water.

2. Linimentum Terebinthinæ Aceticum.—Oil of Turpentine 53 per cent., liniment camphor 5 per cent., glacial acetic acid 11 per cent.

ACTION OF OIL OF TURPENTINE

External.—The oil of turpentine, when applied to the skin or mucous membrane, is an **antiseptic** with an **irritant** effect. If the application is prolonged or it is rubbed into the skin it causes redness of the skin, and even vesication accompanied by severe pain, due to the dilatation of the blood vessels and irritation of the sensory nerve endings in it. Later on the nerve endings are depressed producing numbness. It is, therefore, a **rubefacient** and an **anæsthetic,** and is used as a **counter-irritant.**

Internal.—*Alimentary Tract.*—In the mouth, it causes reflex salivation. In the stomach, it dilates the blood vessels, and increases the secretion of the gastric juice and acts as a **stomachic.** It acts directly on the muscular coat of the stomach to relax its spasmodic activity and to co-ordinate its movements, which relieve flatulence and colic. It, therefore, acts as a **carminative.** In the intestine, the same action is produced. In large doses, however, the oil of turpentine irritates the intestine and causes purgation. In cases of intestinal hæmorrhage, it acts as a local **hæmostatic.** It is also an **anthelmintic** and is given in enemata for thread worms.

Absorption and Elimination.—It is absorbed from all surfaces, but is readily taken up by the respiratory mucous membrane, and all its systemic effects may be produced when administered by inhalation. It is partly oxidised in the body and partly excreted by the kidneys, lungs and sweat.

Blood.—It circulates in the blood unchanged and increases the number of white blood corpuscles.

Circulatory System.—Beyond the reflex stimulating effect when taken by the mouth, the oil of turpentine has very little direct action on the heart after absorption. It, however, **stimulates the vaso-motor centre and causes contraction of the blood vessels with a consequent rise of blood pressure.** Large doses depress the vaso-motor centre and cause the blood pressure to fall.

Respiratory System.—The oil of turpentine, when inhaled or during its excretion through the bronchial mucous membrane, purely by its local action stimulates and disinfects the secretion of the bronchi. The increased secretion excites reflex cough, and thus it acts as an **expectorant.** This effect is further helped by the increased respiratory activity induced by the stimulation of the respiratory centre.

Nervous System.—Moderately large doses of the oil of turpentine depress the nervous system, as is shown by heaviness, drowsiness, unsteady gait and debility. Toxic doses may lead to coma and paralyse the sensory nerve with consequent loss of reflex action.

Kidneys.—It is a stimulant **diuretic,** producing in large doses active irritation or congestion of the urinary organs. The urine is scanty and high coloured and contains albumen and blood. There is an odour of violets to the urine. The irritation spreading to the bladder causes frequent and painful micturition. In large doses the suppression of urine is common.

Skin.—The oil of turpentine, during its excretion through the skin may cause erythematous rash to appear on the body. The temperature is lowered slightly.

The oil of turpentine is used as an antidote in cases of poisoning by phosphorus, but its utility is doubtful.

THERAPEUTIC USES

The oil of turpentine is used externally as a counter-irritant to relieve pains of diverse origin—lumbago, myalgia, pains around the joints, etc. In the form of a stupe (flannel wrung out of hot water and sprinkled with oil of turpentine) it is used in bronchitis, pneumonia, pleurisy, peritonitis, flatulent colic and tympanitis. Internally, it is given as a hæmostatic in bleeding from the lungs, stomach, intestines and uterus. Large doses of turpentine suspended in mucilage are given as an anthelmintic for tape worms, but this treatment may cause serious gastro-intestinal irritation and inflammation of the urinary passages. In the form of an enemata, it is given as an anthelmintic for thread worms. Recently the oil of turpentine is used to provoke leucocytosis by a "fixation abscess" (the sterile abscess produced by the subcutaneous or intramuscular injection of 0·5 to 1 c.c. of 15 per cent. solution of turpentine in sterile olive oil) in the treatment of infections such as septicemia and pyæmia, pneumonia, typhoid fever, erysipelas, etc. Its use is contra-indicated in all kidney diseases.

TAR

Pix Liquida.—Wood Tar. A bituminous liquid obtained by destructive distillation from the wood of various trees of the family *Pinaceæ*. It occurs as a brownish black viscous liquid with a peculiar aromatic odour. It is partially soluble in alcohol (90 per cent.) and very slightly in water. It is a complex mixture containing *oil of turpentine*, *resin*, *phenols*, *pyrocatechin*, and *acetic acid*.

Dose—2 to 10 grs.—0·12 to 0·6 G.

Pix Carbonis Præparata.—Prepared Coal Tar. It is obtained by heating commercial coal tar, so as to drive off the ammonia it contains.

Liquor Picis Carbonis.—20 per cent. of alcoholic solution with Quillaia.

ACTION AND THERAPEUTIC USES

External.—It is an antiseptic and irritant to the skin, but, as compared with oil of turpentine, it is not so powerful. It exerts a feeble local anæsthetic effect. It is a **parasiticide** and is used in scabies, dry eczema, psoriasis and other skin diseases. It relieves the itching of pruritis.

Internal.—Some of its constituents are excreted by the bronchial mucous membrane and they increase and disinfect its secretion. It therefore acts as an **expectorant.** Now-a-days, it is rarely prescribed internally.

OIL OF CADE

Oleum Cadinum. *Synonym.*—Juniper Tar Oil. It is an oily liquid obtained by destructive distillation of the wood of *Juniperus oxycedrus*. A dark brown liquid with a tarry odour and aromatic taste. Its action and uses are the same as tar, but it is to be preferred to the latter as being a more sightly application and as having a more pleasant odour.

COLOPHONY

Colophonium. *Synonyms.*—Resina, Resin. It is the residue left after the distillation of the oil of turpentine from the oleoresin of various species of *Pinus*. It occurs in translucent, yellowish brittle, pulverisable masses, having an odour and taste like turpentine. It is soluble in alcohol, alkalies and ether. Its chief constituent is *abietic acid*, a crystalline substance.

Emplastrum Colophonii. *Synonym.*—Adhesive Plaster. Contains resin, lead plaster and soap.

ACTION AND THERAPEUTIC USES

Resin is an **antiseptic** and a **stimulant** used as an application for indolent ulcers, sores and wounds.

OIL OF CAJUPUT

Oleum Cajuputi.—The oil distilled from the leaves of *Melaleuca leucadendron* and other species of *Melaleuca*. It is a transparent, bluish green liquid, with a penetrating camphoraceous odour and an aromatic, slightly bitter taste. It contains a large quantity of *cineole*, isomeric with borneo camphor.

Dose—1 to 3 ms.—0·06 to 0·2 mils.

Spiritus Cajuputi.—10 per cent. in alcohol (90 per cent.).

Dose—5 to 30 ms.—0·3 to 2 mils.

ACTION AND THERAPEUTIC USES

Like many of the volatile oils, cajuput is an **antiseptic,** and is more so than other volatile oils. It is used as a stimulant and counter-irritant for inflamed and painful joints. It is given internally as a **carminative, stomachic** and an **antispasmodic.**

OIL OF EUCALYPTUS

Oleum Eucalypti.—The oil distilled from the fresh leaves of *Eucalyptus globulus* and other species of *Eucalyptus*. It occurs as a light yellow mobile liquid, of a camphoraceous odour and a spicy cooling taste. It is readily soluble in alcohol. Its chief constituent is *cineole*, of which it contains not less than 70 per cent.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Eucalyptol. *Synonyms.*—Cineole. It is an organic compound obtained from the oil of Eucalyptus. It is the anhydride of turpin or menthandiol and occurs as a colourless liquid, having a characteristic, aromatic camphoraceous odour and a pungent spicy taste. It is slightly soluble in water, and miscible with alcohol, chloroform, ether, and fixed and volatile oils.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Action of Oil of Eucalyptus

External.—It is the least irritating of the volatile oils and is even supposed to have a slight **anæsthetic** action in addition to the **antiseptic** one.

Internal.—In small doses, its action is similar to that of turpentine acting as a **stomachic** and a **carminative.** In large doses, it is a gastro-intestinal irritant. After absorption, it is an **antipyretic** and an **antiperiodic,** like quinine. It prevents the diapedisis of the white blood corpuscles. During the process of its excretion, it stimulates the bronchial mucous membrane to increase and disinfect its secretion. It stimulates the kidneys to act as a **diuretic** and disinfects the genito-urinary tract imparting to the urine the odour of violets, as turpentine does. Eucalyptol mainly acts as vermifuge and an expectorant. Locally, in the form of a spray, it is used as an antiseptic for the mucous membrane of the nose and throat.

Therapeutic Uses

The oil of eucalyptus and eucalyptol are inhaled or given internally as a pulmonary antiseptic in catarrhal colds, tuberculosis of the lungs and in pulmonary gangrene. As a urinary antiseptic, it is given in pyelitis and crystitis. It has been given in ague, typhoid, fevers and septicæmia and pneumonia.

OIL OF ROSEMARY

Oleum Rosmarini.—A colourless pale yellow volatile oil distilled from the flowering tops of *Rosmarinus officinalis.* It must contain not less than 10 per cent. of total alcohols calculated as *borneol.*

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Action and Therapeutic Uses

The oil of Rosemary has action similar to that of other aromatic volatile oils. It is used to give a pleasant scent to hair lotions and other preparations which are used externally. It is employed chiefly as a **rubefacient** and **counter-irritant.**

Class II

CARMINATIVE GROUP

CLOVES

Caryophyllum.—Cloves. The dried flower-buds of *Eugenia Caryophyllata*, having a strongly aromatic odour and a pungent aromatic taste, followed by numbness. It contains the official volatile oil 20 per cent. and a neutral body, *caryophyllin* isomeric, with camphor.

Dose—1 to 5 grs.—0·12 to 0·3 G.

1. Infusum Caryophylli Recens.—2·5 per cent. in boiling water.

Dose—½ to 1 fl. oz.—15 to 30 mils.

2. Infusum Caryophylli Concentratum.

Dose—½ to 1 fl. dr.—2 to 4 mils.

Cloves are contained in Pulvis Cretæ Aromaticus and Pulvis Cretæ Aromaticus cum Opio.

Oleum Caryophylli.—Oil of Cloves. The oil distilled from cloves. It is a colourless oil becoming darker and thicker by age or exposure to air. It has the characteristic odour and taste of cloves, and is soluble in spirit or ether. It contains 85 per cent. of *Eugenol* which chemically resembles phenol, and forms permanent salts with alkalies.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Oil of cloves is contained in Pilula Colocynthidis et Hyoscyami.

ACTION AND THERAPEUTIC USES

Oil of cloves acts like other volatile oils and has all their typical actions. Cloves are mainly used in cookery in combination with other spices to promote palatability and to stimulate appetite. Oil of cloves is a favourite remedy for toothache. It is applied on a pledget of cotton which is to be inserted into a carious cavity. It is locally applied to relieve neuralgic pains. In the pills of colocynth, it is used as a carminative to prevent their griping tendencies.

NUTMEG

Myristica.—Nutmeg. The dried kernel of the seeds of *Myristica fragrans*. It has very little odour unless powdered. The taste is warm, bitter and aromatic. It contains a *fixed oil*, a *volatile* oil and a *bitter principle*.

Dose—5 to 10 grs.—0·3 to 0·6 G.

It is contained in Pulvis Cretæ Aromaticus.

Oleum Myristicæ.—Volatile oil of nutmeg, obtained by distillation. It contains a *terpene*, *myristicin*, and other aromatic substances.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

It is contained in Tinctura Valerianæ Ammoniata and Spiritus Ammoniæ Aromaticus.

ACTION AND THERAPEUTIC USES

It has the same action as other aromatic oils. It is used in combination with other spicy substances for culinary purpose. In large doses, it induces narcosis.

CINNAMON

Cinnamomum. *Synonym.*—Cinnamomi Cortex. The dried inner bark of shoots from the truncated stock of *Cinnamomum Zeylanicum*. It occurs in the form of closely rolled quills, containing small quills, having a sweet aromatic pungent taste, and a fragrant odour. It contains the official *volatile oil*, *sugar tannic acid* and *gum*.

Dose—5 to 20 grs.—0·3 to 1·2 G.

It is contained in Pulvis Cretæ Aromaticus and Tinctura Cardamomi Composita.

Aqua Cinnamomi Distillata.—10 per cent. by distillation.

Dose—1 to 2 fl. ozs.

Oleum Cinnamomi.—The oil distilled from cinnamon bark. A yellowish liquid, acquiring a reddish brown colour and becoming thicker by age or exposure to air. It has the characteristic odour and taste of cinnamon. It contains about 60 per cent. *cinnamic aldehyde* and *cinnamic acid.*

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Aqua Cinnamomi Concentrata.—2 per cent. in alcohol (90 per cent.) and distilled water.

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

Cinnamon has the same action as other aromatic oils. It is a **carminative** and **stomachic.** It has a slight **astringent** action in virtue of the tannic acid in its composition.

CARDAMOM

Cardamomum. *Synonym.*—Cardamomi Semina. Cardamom seeds. The dried ripe seeds of *Elettaria Cardamomum.* The seeds are retained in their pericarps to preserve their aroma, and are separated only when they are required for use. The fruit is a three sided capsule of a tough papery character, ovoid in shape, and containing small reddish brown or black seeds, which are whitish within. They have an aromatic odour, and pleasant warm aromatic taste. The chief constituent of the seed is a *volatile oil,* containing *a terpene.*

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Tinctura Cardamomi Composita.**—Contains 2 per cent. of cardamom with cinnamon, caraway and cochineal in 50 per cent. alcohol (45 per cent.) with some glycerine.

Dose—½ to 1 fl. dr.—2 to 4 mils.

2. **Tinctura Cardamomi Composita Concentrata.**—It has approximately four times the strength of Compound Tincture of Cardamom.

Dose—8 to 15 ms.—0·5 to 1 mil.

It is contained in Mistura Sennæ Compositum. Cardamom seeds are used as a flavouring agent in a variety of other important preparations.

ACTION AND THERAPEUTIC USES

Cardamom seeds and their preparation are mainly used as **flavouring** and **carminative agents.**

GINGER

Zingiber.—The scraped and dried rhizome of *Zingiber officinale*. It occurs as flattish irregularly branched pieces, with a depressed scar at the summit of each branch. Odour is aromatic, and taste pungent. It contains an aromatic *volatile oil*, *gingerol*, several *resins* and allied bodies.

Dose—5 to 15 grs.—0·3 to 1 G.

1. **Tinctura Zingiberis Fortis.** *Synonym.*—Essence of Ginger. 50 per cent. in alcohol (90 per cent.).

   Dose—5 to 10 ms.—0·3 to 0·6 mil.

2. **Tinctura Zingiberis Mitis.**—20 per cent. of essence of ginger in alcohol (90 per cent.).

   Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Syrupus Zingiberis.**—5 per cent. of essence of ginger in alcohol (90 per cent.).

   Dose—½ to 2 fl. dr.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

It is chiefly used as a **stomachic, carminative** and a flavouring agent.

CAPSICUM

Capsicum. *Synonyms.*—Capsici Fructus. Pod Pepper. The dried ripe fruit of *Capsicum minimum*. It is an oblong conical fruit having a brownish red, shining, smooth, translucent pericarp, enclosing several small, roundish, flat seeds. Odour characteristic, and taste intensely pungent. It contains *capsaicin*, a crystalline, pungent substance, *a volatile oil*, a liquid alkaloid, red colouring matter, resin, etc.

Dose—½ to 2 grs.—0·3 to 0·12 G.

1. **Tinctura Capsici.**—5 per cent. in alcohol (60 per cent.).

Dose—5 to 15 ms.—0·3 to 1 mil.

2. **Tinctura Capsici Concentrata.**—It has approximately four times the strength of Compound Tincture of Capsicum.

Dose—1 to 4 ms.—0·06 to 0·25 mil.

3. **Unguentum Capsici.**—25 per cent. in hard and soft paraffin and lard.

ACTION AND THERAPEUTIC USES

Capsicum, externally, is a powerful **rubefacient, irritant** and **counter-irritant** and is largely used in the form of ointment in rheumatism, lumbago, and neuralgia. Its diluted tincture is used as a stimulant gargle in the relaxed condition of the throat.

Internally, capsicum is an aromatic **carminative** and a **diffusible stimulant.** It increases the flow of saliva, imparts a feeling of warmth to the stomach, stimulates its secretion, accelerates peristalsis and relieves gastric and intestinal flatulence. It is of particular service in chronic catarrh of alcoholic subjects, as it not only restores the tone of the gastric mucous membrane but also relieves the craving for alcohol.

OIL OF LAVENDER

Oleum Lavendulæ.—The oil distilled from the flowers of *Lavendula officinalis*. It is a pale yellow oil with a fragrant odour and a pungent bitter taste. It is partially soluble in alcohol. It contains not less than 30 per cent. of *esters* calculated as *linalylacetate*.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

It is contained in Linimentum Camphoræ Ammoniatum.

ACTION AND THERAPEUTIC USES

It has the same action as other aromatic oils. It is used in pharmaceutical preparations as a colouring and flavouring agent.

OIL OF BITTER ALMOND

Oleum Amygdalæ Volatile Purificatum.—The oil is obtained by distillation from the cake left after pressing out the fixed oil from bitter almonds, peach kernels, or apricot kernels and purified by the removal of hydrocyanic acid. It is a pale yellow liquid, with the odour and taste that of bitter almonds.

Dose—¼ to 1 m.—0·016 to 0·06 mil.

Action and Therapeutic Uses

It has the same action as other aromatic oil. It is used in pharmaceutical preparations as flavouring agent.

OIL OF PEPPERMINT

Oleum Menthæ Piperitæ.—The oil distilled from the fresh flowering peppermint, *Mentha piperata*. It is a pale yellow oil becoming darker by age. It has the odour of peppermint and a pleasant aromatic taste, followed by a sensation of coldness. It is soluble partially in alcohol. It yields not less than 5 per cent. of *esters*, calculated as *menthyl acetate*, and not less than 16 per cent. of free *menthol*.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

1. **Aqua Menthi Piperitæ Concentrata.**—2 per cent. in alcohol (90 per cent.) and distilled water.

   Dose—5 to 15 ms.—0·3 to 1 mil.

2. **Aqua Menthi Piperitæ Distillata.**—0·5 per cent by distillation.

   Dose—1 to 2 fl. ozs.—30 to 60 mils.

3. **Spiritus Menthæ Piperitæ.**—10 per cent. in alcohol (90 per cent.).

   Dose—5 to 30 ms.—0·3 to 2 mils.

4. **Emulsio Menthæ Piperitæ.**—It contains 10 per cent. oil of peppermint, with a liquid extract of quillaia and water.

   Dose—5 to 30 ms.—0·3 to 2 mils.

Oil of Peppermint is contained in Pilula Rhei Composita.

ACTION AND THERAPEUTIC USES

It has in the main the actions of other aromatic oils. Locally applied, it produces at first the sensation of warmth which is followed by a sensation of coldness and numbness. It is, therefore, used in superficial neuralgias and muscular rheumatism. Internally, it is a favourite flavouring agent ; besides, it has a powerful **stomachic** and **carminative** effect.

OIL OF ANISI

Oleum Anisi. *Synonym.*—Oil of Aniseed. A volatile oil distilled from the ripe anise fruit or from star-anise fruit, *Illicium Verum.* It is a pale yellow oil, having the odour of the fruit and aromatic sweetish taste. It contains *anethol* 85 per cent. and other oxidation products.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

It is contained in Tinctura Opii Camphorata.

ACTION AND THERAPEUTIC USES

It has the same action as that of other aromatic oils ; and it is chiefly used as a **carminative** in children. On account of its slight **expectorant** action, it is used as a basis of cough mixtures and lozenges.

CORIANDER

Coriandrum. *Synonym.*—Coriandri Fructus. The dried ripe fruit of *Coriandrum Sativum.* The seeds, when bruised, have an aromatic odour and an agreeable taste. The chief constituent is the official *volatile oil,* containing *coriandrol* and *pinene.*

Dose—5 to 15 grs.—0·3 to 1 G.

Oleum Coriandri.—Oil of Coriander obtained by distillation. A colourless or pale yellow liquid; odour and taste those of coriander.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

It is contained in Syrupus Sennæ.

ACTION AND THERAPEUTIC USES

It is a carminative and mainly used to disguise the taste of senna and rhubarb.

FENNEL

Fœniculum. *Synonym.*—Fœniculi Fructus. The dried ripe fruit of the cultivated plants of *Fœniculum Vulgare.* They have an aromatic odour and taste, depending upon a *volatile oil* containing *anethol.*

Dose—5 to 10 grs.—0·3 to 0·6 G.

It is contained in Pulvis Glycyrrhizæ Compositus.

ACTION AND THERAPEUTIC USES

It has the same action and uses as other aromatics.

CARAWAY

Carum. *Synonym.*—Carui Fructus. The dried ripe fruit of *Carum Carvi.* The seeds have an aromatic odour and taste. They contain a *volatile oil,* the active principle *carvone, tannin, resin* and *gum.*

Dose—15 to 30 grs.—0·6 to 2 G.

Oleum Cari. *Synonyms.*—Oleum Carui, Oil of Caraway. A volatile oil distilled from caraway fruit. It is a colourless, or pale yellow, oil yielding not less than 50 per cent. by, volume of *carvone.*

Dose—1 to 3 ms.—0·06 to 0·2 mil.

It is contained in Pilula Aloes.

ACTION AND THERAPEUTIC USES

The action of caraway is like that of other aromatic substances and the oil is mainly used as a flavouring agent.

DILL FRUIT

Anethum. *Synonym.*—Anethi Fructus. The dried ripe fruit of *Anethum Graveolens.* The fruit is composed of two mericarps, usually separate and freed from the pedicle. It has an aromatic odour and taste. It contains an official *volatile oil.*

Aqua Anethi Distillata.—10 per cent. by distillation.

Dose—½ to 1 fl. oz.—15 to 30 mils.

Oleum Anethi.—Oil of Dill distilled from dill. It contains not less than 48 per cent. and not more than 63 per cent. of carvone.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

Aqua Anethi Concentrata.—2 per cent. in alcohol (90 per cent.) and distilled water.

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

The actions and uses of dill are similar to those of other aromatic substances. It is a favourite carminative for children and disguises the taste of sodium salts.

Class III

EXPECTORANT GROUP

TEREBENE

Terebenum.—It is a mixture of *dipentene* and other *hydrocarbons,* obtained from the oil of turpentine. It occurs as a colourless liquid with a pleasant pine-wood odour. It is insoluble in water, but easily emulsified with tragacanth, or it may be taken on a lump of sugar or in capsule.

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

Terebene, a derivative of turpentine, is less irritating locally and has much less disagreeable taste than turpentine, and is therefore preferred to it as a stimulating **disinfectant expectorant,** whether internally or in the form of an inhalation. It is also of service in flatulence and in cystitis.

BALSAM OF PERU

Balsamum Peruvianum.—A balsam exuded from the trunk of *Myroxylon pereiræ*, after the bark has been beaten or scorched. It occurs as a dark-brown, viscid liquid appearing reddish brown in thin layers. It has an agreeable odour and a persistent acrid taste. Insoluble in water, but soluble in alcohol and chloroform; it is a complex substance containing a *volatile oil* in large quantity, *cinnamic acid*, *benzoic acid* and *resins*.

Dose—5 to 15 ms.—0·3 to 1 mil. Given emulsified with mucilage or yolk of egg.

ACTION AND THERAPEUTIC USES

Externally, it is an **antiseptic** and a **stimulant** to the raw surfaces or when rubbed into the skin. It is mainly used as a **parasiticide** for the cure of ring-worm, itch, pediculi, etc. Internally, it is an **expectorant** of a stimulant and disinfectant character, for chronic bronchitis and phthisis.

BALSAM TOLU

Balsamum Tolutanum.—A balsam exuded on incision from the trunk of *Myroxylon toluiferum*. It occurs as a yellowish-brown plastic mass, becoming brittle by keeping or exposure to cold. It has a fragrant odour and aromatic taste soluble in alcohol. It is a complex substance containing a *resin* yielding *benzoic* and *cinnamic acids* and their salts and *vanillin*.

Dose—5 to 15 grs.—0·3 to 1 G. Given emulsified with mucilage or yolk of egg.

1. **Syrupus Tolutanus.**—2·5 per cent. in syrup.

Dose—½ to 2 fl. drs.—2 to 8 mils.

2. **Tinctura Tolutana.**—10 per cent. in alcohol (90 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Tinctura Tolutana Concentrata.**—It has approximately four times the strength of Tincture of Tolu.

Dose—8 to 15 ms.—0·5 to 1 G.

Action and Therapeutic Uses

Balsam Tolu is a mild **expectorant,** and is chiefly used in the form of syrup, as a pleasant vehicle for other more powerful expectorants.

STORAX

Styrax Præparatus.—Prepared Storax. A viscid balsam obtained from the wounded trunk of *Liquidambar Orientalis*. It occurs as a semi-fluid, adhesive substance, brownish yellow on the exposed surface and greenish grey within. The odour is strong and the taste balsamic. It contains *cinnamic* and *benzoic acids* and their derivatives.

Dose—10 to 30 ms.—0·6 to 2 mils.

Action and Therapeutic Uses

Styrax is an ingredient of the compound tincture of benzoin but is otherwise seldom given internally. It is a feebly **antiseptic expectorant.** Mixed with olive oil or cottonseed oil, it is an effective **parasiticide,** in scabies and pediculosis.

OIL OF SIBERIAN FIR

Oleum Abietis. *Synonyms.*—Oil of Pine. The oil obtained by distillation from the fresh leaves of *Abies Sibirica.* An almost colourless oil, with an agreeable pinic odour and pungent taste; soluble in alcohol. It contains various *turpenes* and *bornyl acetate.*

ACTION AND THERAPEUTIC USES

Oleum Abietis resembles in action the oil of turpentine. Being pleasanter to inhale, it is mainly used by inhalation as a stimulating disinfectant expectorant in various respiratory catarrhs.

Class IV

THE DIURETIC GROUP.

COPAIBA

Copaiba.—Copaiva. The oleo-resin obtained by incision from the trunk of various species of *Copaifera.* It occurs as a more or less viscid liquid having a pale-yellow colour with a slight greenish fluorescence. It has a peculiar aromatic odour, with a persistent bitter acrid taste. It is insoluble in water, partly soluble in alcohol, and easily soluble in fixed and volatile oils. It is improperly called balsam copaiba, as it contains no benzoic acid. It contains a *volatile oil, copaivic acid* and a non-crystallizable viscid *resin.*

Dose—10 to 30 ms.—0·6 to 2 mils. It is given emulsified with 2½ times as much mucilage.

ACTION OF COPAIBA

External.—Copaiba is a stimulant to the skin.

Internal.—*Alimentary Tract.*—It acts like other volatile oils producing a sensation of warmth at the epigastrium ; in large doses, it acts as a gastro-intestinal irritant producing indigestion, vomiting and diarrhœa. Its drawbacks are its nasty taste and unpleasant eructations.

Mucous Membranes.—It is quickly absorbed and excreted by all the mucous membranes stimulating and disinfecting them during the process of excretion. It is therefore an **antiseptic expectorant** and **disinfectant to the genito-urinary tract.** During the process of elimination by the skin, it gives rise to a rash resembling measles.

Kidneys.—Its marked action on the kidneys, which are stimulated in small doses, is to increase their secretion. It is thus a **diuretic.** In large doses, it irritates the kidneys to lessen their secretion and to cause albuminuria, and sometimes hæmaturia.

THERAPEUTIC USES

Copaiba is mainly used to disinfect the genito-urinary tract in cases of pyelitis, cystitis, vaginitis and gonorrhœa. It is sometimes used as an antiseptic expectorant when the secretion is very foul. The resin of copaiba is an efficient diuretic, and is given with benefit for the relief of cardiac and hepatic dropsies, but not in Bright's disease.

OIL OF SANDAL WOOD

Oleum Santali.—Oil of Sandal Wood. *Synonym.*—Santal Oil. The volatile oil is distilled from the wood of *Santalum Album.* It is a pale-yellow viscid oil, having a characteristic odour and a spicy taste. It contains 90 per cent. of free *alcohol,* calculated as *santalol.*

Dose—5 to 15 ms.—0·3 to 1 mil.

Oleum Santali Australiensis.—Oil of Australian Sandal Wood. Distilled from the wood of *Eucarya Spicata* and rectified. It contains not less than 90 per cent. of free alcohol calculated as *santalol.*

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

The actions and Therapeutic uses of santol oil are similar to those of copaiba.

BUCHU

Buchu. *Synonym.*—Buchu Folia; Buchu Leaves. The dried leaves of *Barosma Betulina.* The leaves have a characteristic odour and mint-like taste. Their activity depends upon a volatile oil from the oil glands, which are visible on the margins.

Dose—15 to 30 grs.—1 to 2 G.

1. **Infusum Buchu Recens.**—5 per cent. in boiling water.

Dose—1 to 2 fl. ozs.—30 to 60 mils.

2. **Infusum Buchu Concentratum.**

Dose—1 to 2 fl. drs.—4 to 8 mils.

ACTION AND THERAPEUTIC USES

Buchu acts as a **diuretic** and **antiseptic to the urinary tract.** It is used in infections of the urinary tract, especially gonorrhœa and its complications. Incontinence of urine, dependent on irritability of the neck of the bladder, is often relieved by it. Infusion is used as a vehicle for more active diuretics.

Class V

THE NERVINE SEDATIVE GROUP

VALERIAN OR INDIAN VALERIAN

Valeriana. *Synonym.*—Valerianæ Rhyzoma. Valerian Rhizome. The dried rhizome and roots of *Valeriana officinalis* or *Valeriana Wallichii.* It has a very disagreeable odour developed during the process of drying, and the taste, too, is unpleasant, camphoraceous and bitter. The active principle is the *volatile oil*, formed by oxidase during drying and *valerianic acid* formed from the volatile oil by ferment decomposition.

Dose—5 to 15 grs.—0·3 to 1 G.

1. **Tinctura Valerianæ Ammoniata.**—70 per cent. in alcohol (90 per cent.) with ammonia and aromatics.

Dose—½ to 1 fl. dr.—2 to 4 mils.

2. **Tinctura Valerianæ Ammoniata Concentrata.**—It has approximately four times the strength of Ammoniated Tincture of Valerian.

Dose—8 to 15 ms.—0·5 to 1 mil.

ACTION AND THERAPEUTIC USES

Valerian acts by virtue of its volatile oil. It is an irritant when applied externally. Internally, it is a **stomachic, carminative** and an **antispasmodic**. It reflexly stimulates the circulation, and after absorption exerts a powerful **sedative** effect on the nervous system. It is therefore made use of in mild nervous disturbances not dependent on demonstrable lesions, particularly of the hysterical nature. Its effectiveness is heightened by combining it with zinc, which is a depressant to the nervous system. During its excretion through the kidneys and bronchial mucous membrane, it excites the flow of fluids excreted by these parts, and acts as an **expectorant** and a **diuretic** imparting its smell to the urine and breath.

ASAFETIDA

Asafœtida.—An oleo-gum-resin obtained by incising roots of *Ferula fœtida* and, probably, other species of *Ferula*. It comes usually in irregular, more or less pliable masses composed of agglutinated tears of variable size ; its odour is persistent alliaceous ; and the taste bitter acrid and alliaceous. Asafetida, owing to the presence of gum, forms a natural emulsion with water. It contains a *volatile oil*, two *resins*, *gum* and *ferulic acid*.

Dose—5 to 15 [illegible]—0·3 to 1 G.

1. **Pilula Aloes et Asafoetidae.**—Contains asafetida, socotrine aloes, hard soap and confection of roses.

Dose—4 to 8 grs.—0·25 to 0·5 G.

2. **Tinctura Asafoetidae.**—20 per cent. in alcohol (90 per cent.)

Dose—½ to 1 fl. dr.—2 to 4 mils.—The addition of Tincture to water precipitates resin which may be redissolved in ammonia or suspended in mucilage.

ACTION AND THERAPEUTIC USES

Asafetida, both externally and internally, acts like other volatile oils; but its drawback is its disagreeable odour. It is, however, an efficient **carminative** and **antispasmodic**, and is used in flatulent colic, especially in nervous and hysterical subjects, in the aged and in infants. Like valerian, it is a **nervine sedative** and is used in hysterical conditions of nervous exhaustion. This effect is believed to be the result of psychical impression due to the powerful, disagreeable odour and taste of the drug.

MYRRH

Myrrha.—An oleo-gum-resin obtained from the stem of *Commiphora Molmol* and, possibly, other species of *Commiphora*. It occurs as dry rounded or irregular masses, partly covered with a fine yellowish brown powder. The odour is balsamic and aromatic; and the taste aromatic, bitter and acrid. It contains a *volatile oil-myrrhol*, a *resin*, *myrrhin*, and a *gum*. When rubbed with water, it forms a natural emulsion.

Dose—5 to 15 grs.—0·3 to 1 G.

Tinctura Myrrhae.—20 per cent. in alcohol (90 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

Myrrh is contained in Pilula Rhei Composita.

ACTION AND THERAPEUTIC USES

External.—Myrrh applied to the skin, is a **rubefacient**, and on the raw surfaces and mucous membranes it is a mild disinfectant and a stimulant.

Internal.—It is used as a mouth-wash for apthous stomatitis and is one of the best applications for inflamed, spongy and receding gums. It is an ingredient of tooth-powders and tooth-washes. In the stomach, it acts as a **stomachic** and **carminative.** It is absorbed in the blood to increase the number of leucocytes. It is excreted by the skin, and genito-urinary and respiratory tracts and stimulates them. It thus acts as a **diaphoretic, expectorant** and **diuretic.** It is also an uterine stimulant and **emmenagogue,** and is given, in combination with aloes and iron, in the amenorrhœa of girls.

GROUP VIII

STEAROPTENES

Camphor, Menthol, Thymol

Stearoptenes are crystalline oxidised products of volatile oils, deposited from them when they are allowed to stand for some time, especially in a cool atmosphere. Chemically and pharmacologically, they resemble the volatile oils, but differ from them in being solid. They are even called **solid volatile oils.**

CAMPHOR

Camphora.—A white crystalline substance, obtained from *Cinnamomum Camphora*, and purified by sublimation. It occurs in white translucent crystalline tough masses or granules, having a penetrating, characteristic odour, and a pungent aromatic taste. It is readily pulverizable in the presence of a little alcohol, ether, or chloroform. It is soluble in about 700 parts of water, and freely in alcohol, chloroform, ether, and fixed and volatile oils. It volatilizes at ordinary temperature, and, when ignited, burns with a bright smoky flame. When rubbed with phenol, menthol, thymol or chloral, it enters into a physical combination with liquefaction and marked lessening of toxicity. It may be obtained synthetically.

Dose—2 to 5 grs.—0·12 to 0·3 G. by subcutaneous injection.

1. **Aqua Camphoræ.**— 0·1 per cent.

Dose—1 to 2 fl. ozs.

2. **Linimentum Camphoræ.** *Synonym.*—Camphorated Oil. 20 per cent. in olive oil. Arachis oil, Cottonseed oil or Sesame oil may be used in place of Olive oil in making this liniment.

3. **Linimentum Camphoræ Ammoniatum.**—12·5 per cent. of camphor, 25 per cent. strong solution of ammonia, in alcohol (90 per cent.) scented with oil of lavender.

4. **Spiritus Camphoræ.**—10 per cent. in alcohol (90 per cent.)

Dose—5 to 30 ms.—0·3 to 2 mils. given in milk or sugar as water precipitates camphor.

5. **Tinctura Opii Camphorata.**—(see opium, page 223).

Camphor is contained in Linimenta Belladonnæ, Saponis, Terebinthinæ and in Unguentum Hydrargyri Compositum ; *Camphor liniment is contained in* Linimenta Chloroformi and Terebinthinæ Aceticum. It is also contained in injections of Bismuth Salicylas, Hydrargyri and Hydrargyri subchloridi.

ACTION OF CAMPHOR

External.—Camphor when rubbed into the skin produces a distinct sensation of cold, dilate the blood vessels and produces partial anæsthesia. It is, therefore, a **rubefacient** and a **local anodyne** and is used as a **counter-irritant.** It has an antiseptic action but much weaker than many of the volatile oils. It is added to some of the official injections for increasing circulation in the part, for promoting absorption and allaying pain.

Internal.—*Alimentary Tract.*—In the mouth, it has a bitter pungent taste, which produces salivation. In the stomach, it produces a sensation of warmth, and dilates the blood vessels, increases the gastric secretion and relieves flatulence. Hence, it is a **stomachic** and **carminative.** In large doses, it irritates the gastric mucous membrane and produces nausea and vomiting. It reflexly stimulates the heart. In ordinary doses, it has very little effect on the intestines.

Absorption and Elimination.—Camphor is quickly absorbed from the skin and mucous surfaces. It is partly oxidised in the tissues to camphoral, and is excreted mainly as glycuronate of camphoral, which is an inactive substance. A small amount is excreted from the skin and lungs.

Blood.—When given by the mouth it increases the number of leucocytes in the blood, probably on account of the increased hyperæmia of the bowel-walls giving rise indirectly to an increased flow of lymph from the thoracic duct.

Circulatory System.—As regards the pharmacological action of camphor on the heart, opinions are conflicting. Clinically, it acts as a **cardiac stimulant.** Small doses of camphor have no direct action on the heart, but they dilate the blood vessels of the skin by its local action on their walls, and cause flushing. In large doses, the heart is slowed by its direct action on the muscle. The vaso-motor centre is at first stimulated and then depressed to cause dilatation of the blood vessels, and as a consequence the blood pressure falls.

Respiratory System.—Moderately large doses of camphor stimulate the respiratory centre and make respiration slower and deeper. In therapeutic doses, the effects of its excretion through the bronchial mucous membrane are more marked, and it acts as an **expectorant.**

Skin and Temperature.—Camphor, during its elimination through the skin, stimulates the sweat glands to increase their secretion and to act as a **diaphoretic.** It acts as an

antipyretic by its local action on the blood vessels as well as by its central action.

Nervous System.—In some cases, camphor acts as an exhilarant, and in others, as an intoxicant or depressant. The excitement may be shown in hilarity, delirium with hallucination, in restlessness or in sudden violent movements which pass into epileptiform convulsions, and ultimately lapse into unconsciousness. In some cases, the patient immediately falls into a condition of drowsiness, unconsciousness and stupor. Camphor is said to be an **aphrodisiac.**

THERAPEUTIC USES

Externally, camphor is used in the form of liniments on account of its stimulant and rubefacient effects. Internally, it is given for flatulence, as an intestinal antiseptic; and combined with opium for diarrhœa and cholera. It is also given in various nervous affections, such as insanity, hysteria, and whooping cough; in irritable conditions of the genito-urinary organs; as a cardiac stimulant in acute febrile diseases, in alcoholism, in narcotic poisoning. It is commonly used as an expectorant and a diaphoretic.

MENTHOL

Menthol. *Synonym.*—Peppermint Camphor. A crystalline substance obtained by cooling the oil distilled from the fresh herb of *Mentha arvensis* (vars piperascens et glabrata) and probably other species of *Mentha*. It occurs as colourless acicular crystals, having a strong peppermint-like odour and taste, producing a sensation of warmth on the tongue with a subsequent sensation of coldness if the air is inhaled. It is sparingly soluble in water but very soluble in alcohol, liquid paraffin, and in fixed and volatile oils. It volatilizes when exposed to the air.

Dose—[illegible]

ACTION AND THERAPEUTIC USES

External.—The most striking effect of menthol, when applied to the skin, is the sensation of coldness which it produces by the direct stimulation of the nerves of temperature-sense and not by evaporation. This leads to a slight **analgesic** effect, which is taken advantage of to alleviate the pain of neuralgias especially of the superficial nerves. When rubbed into the skin or when its application is prolonged, it acts as a **rubefacient** and a **counter-irritant.** It relieves itching in urticaria or prurigo. It is applied locally in combination with camphor phenol or chloral to carious teeth for the relief of toothache. As a paint, it is applied locally in olive oil or in liquid paraffin, to the throat, in cases of pharyngitis or laryngitis. It is an ingredient of many antiseptic mouth-washes.

Internal.—It is rarely given as it upsets digestion. It has however the same action as camphor.

THYMOL

Thymol. *Synonyms.*—Isopropyl metacresol; Thymic acid. A crystalline substance obtained from the volatile oils of *Thymus Vulgaris*, *Monarda Punctata* and of *Trachyspermum Ammi*, purified by crystallization from alcohol. It occurs in large colourless translucent, rhombic prisms, having thyme-like odour and pungent aromatic taste. It is almost insoluble in water, partly soluble in glycerine, soluble in olive oil and freely in alcohol, ether and chloroform.

Dose—½ to 2 grs.—0·03 to 0·12 G. (antiseptic).
15 to 30 grs.—1 to 2 G. (anthelmintic).

ACTION AND THERAPEUTIC USES

Thymol, like carbolic acid, is a powerful **antiseptic.** It is much less irritant than carbolic acid, and the only disadvantage it possesses is its insolubility in water. In alcoholic 5 per cent. solution, it is used as a **parasiticide** in cases of ringworm. Internally, in small doses, thymol is an **intestinal antiseptic,** and in massive doses it is an **anthelmintic** for ankylostomum duodenale. It is best given in capsule, on an empty astomach, in 15 grs. doses, every two hours. The last dose must be followed in an hour by a saline purgative to prevent retention of thymol in the intestine, as it causes intestinal inflammation if allowed to remain. Fatty and spirituous substances must not be allowed during the treatment, as they dissolve thymol and cause rapid absorption into the system to produce symptoms of poisoning.

GROUP IX

DRUGS USED SPECIFICALLY TO KILL OR EXPEL INTESTINAL WORMS.

ANTHELMINTICS

Class I.—Anthelmintics for the Round Worms (Ascaris Lumbricoides).—Santonin.

Class II.—Anthelmintics for the Tape Worms.—Male Fern, Pelletierine Tannate.

Class III.—Anthelmintics for the Hook Worms (Ankylos toma duodenale).—Oil of Chenopodium, Thymol, Carbon tetrachloride.

Class IV.—Anthelmintics for the Thread Worms (Oxyuris Vermicularis.)—Oil of Chenopodium, Bitters, Oil of Turpentine. (The last two are already described.)

Class I

ANTHELMINTICS FOR ROUND WORMS

SANTONIN

Santoninum.—Santonin. A neutral crystalline principle obtained from Santonica, the dried unexpanded flower heads of ***Artemisia cina*** and other species of ***Artemisia.*** It occurs in colourless, flat, rhombic prisms, or as a white crystalline powder. It is odourless and tasteless at first, but afterwards develops a bitter taste. It rapidly becomes yellow when exposed to light, and is almost insoluble in water.

Dose—1 to 3 grs.—0·06 to 0·2 G.

ACTION AND THERAPEUTIC USES

Santonin does not kill the worm in the intestinal canal, but so irritates them as to relax their hold upon the mucous membrane and to compel them to pass from the small bowels into the colon from which they are expelled by a purge. It has no action on the other intestinal parasites. Santonin is absorbed to a slight extent from the stomach as well as from the intestine. It is excreted in the urine and fæces, partly unchanged and partly in the form of oxysantonin, giving these a yellow colour, which changes to red or purple in the presence of alkalies. After absorption, it gives rise to a series of peculiar symptoms. The earliest symptom to occur is the disturbance of vision. There is a characteristic perversion of the colour sense. Everything the patient sees has an yellow tint and this yellow vision is termed **Xanthopsy.** This is due to the specific action of the drug on the nerve-mechanism of sight, most probably the retina or visual centre, and not due to the colouration of the ocular humours.

In large doses, the cerebral symptoms are more marked. The central nervous system is stimulated at first and then depressed. There are epileptiform convulsions, followed by loss of consciousness and failure of the respiratory centre. Children are very susceptible to santonin and on account of its toxicity, it should be prescribed with caution.

Therapeutically, santonin is hardly used for any other purpose than as a vermifuge. Recently, however, yellow santonin prepared by oxidising it by exposure to the sun for a period of 3 to 6 months, it is said to have intestinal antiseptic properties, and is used in amœbic dysentery, typhoid fever and sprue ; but this action of yellow santonin is doubtful.

Class II

ANTHELMINTICS FOR TAPE WORM

MALE FERN

Filix Mas. *Synonym.*—Aspidium. The rhizome of *Dryopteris Filix-mas* collected late in the autumn, divested of its roots, leaves and dead portions, and carefully dried and preserved. It has a slight disagreeable odour, and an astringent, bitter, acrid taste.

The active constituents of filix-mas are in the oleoresin it contains ; the chief being *filicic acid* which separates out as white crystals on standing. These must be thoroughly mixed with oil before use.

Dose—60 to 180 grs.—4 to 12 C.

Extractum Filicis. *Synonym.*—Extractum Filicis Liquidum, Oleoresina Aspidii. Obtained by percolating the drug with ether which is then evaporated, and an oily liquid, oleoresin, is left. It is standardized to contain the 25 per cent. of filicin.

Dose—45 to 90 ms.—3 to 6 mils. It must be given emulsified, as the water precipitates the resin.

ACTION AND THERAPEUTIC USES

Male fern is one of the most reliable agents for the **expulsion of tape-worms.** It owes its usefulness to the fact that in therapeutic doses, it is not absorbed from the digestive tract to give rise to systemic symptoms. Oils, however, favour the solution and absorption of its oleoresin, which when absorbed, is extremely toxic, causing irritation of the gastro-intestinal tract with vomiting and diarrhœa and inflammation of the kidneys, through which a portion of it is excreted. In more severe cases, convulsions or coma supervenes. There may be optic neuritis leading to temporary or rarely permanent blindness. The administration of an oily purge should, therefore, be avoided in expelling the worm from the intestinal tract.

PELLETIERINE TANNATE

Pelletierinæ Tannas.—A mixture of the tannates of the several alkaloids obtained from the bark of the stem and root of the *Punica Granatum.* It occurs as a light-yellow amorphous powder without odour but with an astringent taste ; slightly soluble in water, more in alcohol.

Dose—2 to 8 grs.—0·12 to 0·5 G.

ACTION AND THERAPEUTIC USES

Pelletierine is a specific for tape-worms but being a local irritant it gives rise to vomiting and colicky pain ; it likewise causes nervous disturbances—headache and vertigo. The tannate of the alkaloid is generally preferred for internal administration. Being insoluble in the stomach, it passes unchanged into the intestines, where the alkaloids are slowly liberated to kill the tape-worm. It should be given on an empty stomach and be followed after two hours by a purge. As alcohol favours its solution and absorption, alcoholic preparations should be avoided after its administration.

Class III

ANTHELMINTICS FOR HOOK-WORMS

OIL OF CHENOPODIUM

Oleum Chenopodii. *Synonym.*—Oil of American Worm seed. It is the oil distilled with steam from the fresh and fruiting plants, excluding the roots, of *Chenopodium Ambrosioides* var. *anthelmenticum.* It occurs as a colourless or pale-yellow liquid with a characteristic unpleasant odour and a burning bitter taste. It contains 65 per cent. of ascaridole.

Dose—3 to 15 ms.—0·2 to 1 mil.

ACTION AND THERAPEUTIC USES

Oil of Chenopodium is principally used as a **vermicide against hook-worm and round-worm.** Like other volatile oils, it is a diffusible stimulant, excites warmth at the epigastrium, increases cardiac and peristaltic activity and stimulates the secretions. It kills the worms but does not expel them. It should, therefore, be given emulsified with castor oil. It is said to act as an **antispasmodic** and an **emmenagogue.** In poisonous doses it depresses the central nervous system and the heart.

CARBON TETRACHLORIDE

Carbonei Tetrachloridum.—A clear colourless volatile liquid with a characteristic odour and burning taste. It is not inflammable. It is slowly decomposed by light and gives rise to acrid odour. Insoluble in water but miscible with alcohol and ether.

Dose—30 to 60 ms.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

Carbon Tetrachloride is a narcotic of the chloroform type but in action is less rapid and more prolonged than chloroform. It is absorbed from all mucous surfaces and when given by the mouth, the absorption is interfered with by the presence of food in the stomach but it is favoured by alcohol ingested soon after its administration. After absorption, a portion of it is stored up in the liver from which it is slowly liberated so that in therapeutic doses systemic poisoning effects are not seen. It is partly excreted by the lungs. During its passage through the intestine, it exerts its specific action of destroying hook-worms and at the same time stimulating the peristaltic action so as to cause their expulsion. It may act on other intestinal parasites but not so effectively. Therapeutically, therefore, carbon tetrachloride is used only as an **anthelmintic** for **hook-worms.** The best vehicle for its administration is water. It should not be given with fats or with alcohol. If there be no purgative action for 24 hours, an adequate dose of magnesium sulphate should be used.

GROUP X

SUBSTANCES ACTING AS DEMULCENTS, EMOLLIENTS, SWEETENING AND COLOURING AGENTS

Demulcents.—Tragacanth, Gum acacia, Indian gum, Liquorice, Linseed, Starch, Gelatin, Honey.

Emollients and External Protectives.—Pyroxilin. Olive oil, Cotton seed oil, Almond oil, Arachis oil, Sesame oil, Oil of Theobroma, Soap, Oleic acid, Glycerine, Suet, Lard, Wax, Paraffin.

Sweetening and Colouring Agents.—Sugar Glucose; Lævulose; Sugar of Milk, Cochineal.

DEMULCENTS

General Remarks.—Demulcents are substances which form a colloidal solution when mixed with water, and are mainly used as an application to mucous surfaces to soothe irritation. Their adhesive nature serves to protect the part mechanically by forming a protective surface to preserve the mucous membrane from irritant agents and to retard absorption of fluids. Though in themselves they have often no taste or odour, they markedly diminish the characteristic tastes of all substances—sweet, pungent, acid, as well as bitter. After absorption they loose their demulcent effect and are oxidised in the tissues to act as food, but their slow absorption prevents their being of much value. Externally, they are rarely used, as they are liable to serve as media for the growth of micro-organisms.

TRAGACANTH

Tragacantha.—A gummy exudation obtained by incision from *Astragalus Gummifer* and other species of *Astragalus*. It occurs in flattened lamellated flakes of varying size and shape, and somewhat translucent. It is odourless and almost tasteless.

1. **Mucilago Tragacanthæ.**—1·25 per cent. in water to which 2·5 per cent. of alcohol (90 per cent.) is added.

2. **Pulvis Tragacanthæ Compositus.**—Contains tragacanth starch, gum acacia and sugar.

ACTION AND THERAPEUTIC USES

Tragacanth is a demulcent and exerts a soothing action when applied to sore throat. It is, however, mainly used in emulsions or suspensions of other drugs, especially fixed and volatile oils. It is particularly of use in suspensions of heavy salts such as bismuth. The emulsions made with compound powder are liable to ferment.

ACACIA

Acacia. *Synonym.*—Acaciæ Gummi. A gummy exudation from the stem and branches of *Acacia Senegal* and other species of *Acacia*. It occurs in ovoid masses, either colourless or with yellowish-brown tint, having no odour or taste. It is freely soluble in water but not in alcohol.

1. **Injectio Sodii Chloridi et Acaciæ.**—Injection of Sodium Chloride and Acacia. Contains 0·9 per cent. of salt and 6 per cent. of acacia.

2. **Mucilago Acaciæ.**—Nearly 65 per cent. in chloroform water; should be freshly prepared.

ACTION AND THERAPEUTIC USES

Acacia is a demulcent and is used in lozenges or troches not only to give body and cohesiveness to the preparation, but also to exert its soothing demulcent action in the throat.

The solution of the gum in them, in the mucous discharge, increases its density and forms a coating which prevents other substances from coming in contact with the irritated surface to cause further irritation. Gum acacia is chiefly used to suspend insoluble substances, as oils, resins and insoluble powders. It is also used as an excipient in pill-making. A sterilized 6 per cent. solution of gum-acacia in normal saline, has the same viscosity and osmotic pressure as the blood and does not therefore diffuse quickly out of the blood vessels. It is, therefore, given intravenously to restore and maintain blood-pressure after severe hæmorrhage.

LIQUORICE

Glycyrrhiza. *Synonym.*—Glycyrrhizæ Radix. Liquorice Root. The dried rhizome and roots of *Glycyrrhiza glabra* and other species. It occurs in nearly cylindrical pieces with a fibrous surface. It has a faint odour and a sweetish taste. It contains grape-sugar, resin, starch, gum and *glycyrrhizin*, a yellow amorphous glucoside.

Dose—15 to 60 grs.—1 to 4 G.

1. **Extractum Glycyrrhizæ.**—20 per cent. in chloroform water. It is a soft extract.

   Dose—10 to 30 grs.—0·6 to 2 G.

2. **Extractum Glycyrrhizæ Liquidum.**—It is made with chloroform water and alcohol (90 per cent.).

   Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Pulvis Glycyrrhizæ Compositus.**—Contains senna, liquorice, fennel, sublimed sulphur and refined sugar.

   Dose—60 to 120 grs.—4 to 8 G.

ACTION AND THERAPEUTIC USES

Liquorice is a favourite demulcent in catarrhal inflammation of pharyngeal and laryngeal mucous membrane. Given in the form of lozenges or in expectorant mixtures, it is employed in many pharmaceutical preparations to cover the taste of nauseous drugs. The compound powder is a laxative in virtue of its senna and sulphur.

LINSEED

Linum. *Synonyms.*—Lini Semina. The dried ripe seeds of *Linum Usitatissimum.* The seeds yield not less than 30 per cent. of *fixed oil.*

Linum Contusum.—Crushed Linseed. *Synonym.*—Linseed meal.

Oleum Lini.—Linseed Oil. The oil expressed from linseed. It occurs as a viscid, yellow liquid having a peculiar odour and bland taste. When exposed to the air, it gradually thickens, darkens in colour and acquires a strong odour and taste.

ACTION AND THERAPEUTIC USES

Linseed meal is chiefly used in the preparation o poultices, being especially adapted to that use by reason of its demulcent property and power of retaining heat and moisture. The poultice is used for its **counter-irritant** effect and its action in inducing local hyperæmia to accelerate inflammation.

Linseed tea is a common domestic demulcent for irritative coughs due to affections of the throat. It is also given as a **demulcent diuretic** in irritation of the genito-urinary tract. Linseed oil in the form of carron oil, is an effective emollient in cases of burns.

STARCH

Amylum.—Starch. Consists of polysaccharide granules obtained from the grains of maize, *Zea mays.*

Glycerinum Amyli.—A jelly-like preparation made with starch, glycerine and a little water.

ACTION AND THERAPEUTIC USES

Starch is mainly used externally as a protective and absorbent for tender and inflamed skins. Boiled to form a stiff paste, it is used when cold, as a demulcent poultice. It is given in the form of a mucilage as an enemata for ulcerated condition of the lower bowels. It is of particular use when given in combination with opium, as starch and opium enemata, in cases of dysentery to relieve the spasmodic activity.

GELATIN

Gelatinum.—A purified product obtained from animal tissues as skin, ligaments and bones, by treatment with boiling water. It occurs in colourless or slightly yellow sheets or flakes, having a faint characteristic odour and taste. It is insoluble in cold water but swells and softens when immersed in it, gradually absorbing from 5 to 10 times its own weight of water. It dissolves in boiling water, the solution solidifying into a jelly on cooling. It is an ingredient of suppositoria glycerini, of all the lamellæ and of urethral and vaginal bougies.

Gelatinum Zinci. *Synonym.*—Unna's Paste. Prepared by incorporating 15 per cent. of zinc oxide in a base made up by soaking gelatin in glycerin and water, and heating on a water bath until gelatin is dissolved.

ACTION AND THERAPEUTIC USES

Gelatin is a food-stuff and may replace a part of the protein of an ordinary diet. It has no topical or systemic action, except on the clotting of blood. It is used as a **demulcent** and forms the basis of lozenges for sore-throat. It is a **hæmostatic,** which could be used locally and could as well be given internally or subcutaneously to favour clotting of the blood. In internal hæmorrhages from the lungs, kidneys, uterus and stomach, and to promote clotting in aneurysm, it is given in 1 or 2 per cent. solution in normal saline either subcutaneously or intravenously; but the disadvantages of this method of administration are that it causes redness and swelling at the site of injection. It might cause tetanus, as commercial gelatin may contain spores of tetanus bacilli and cannot be effectively sterilised without losing its clotting properties. There may occur thrombosis or embolism, which may prove fatal.

HONEY

Mel Depuratum. *Synonym.*—Purified Honey. The honey of commerce is melted and strained through warm flannel, the specific gravity being adjusted to 1·86 by addition of distilled water.

Oxymel.—Honey with ¼ of acetic acid.

Dose—1 to 2 fl. drs.—4 to 8 mils.

It is contained in Oxymel Scillæ and Mel Boracis.

ACTION AND THERAPEUTIC USES

Honey is a **demulcent.** Its sweet taste increases the secretion of saliva and thus relieves thirst and facilitates swallowing. It is a sweetening agent having **laxative** and nutrient properties.

EMOLLIENTS AND EXTERNAL PROTECTIVES

PYROXILIN

Pyroxylinum.—It is a nitrated cellulose, prepared from cotton wool by immersing it in a mixture of sulphuric and nitric acids and then drained and dried. It resembles cotton wool but is harsher to touch and is highly inflammable. Soluble in a mixture of alcohol and ether and in acetone.

Collodium Flexile.—Collodion rendered flexible by addition of castor oil and canada turpentine.

ACTION AND THERAPEUTIC USES

Collodion is used as a protective to small inflamed, broken or incised surfaces; the flexible preparation being preferable, as it does not contract on drying, nor readily cracks.

OLIVE OIL

Oleum Olivæ.—The oil expressed from the ripe fruit of *Olea Europæa* and refined. It is a pale yellow, or greenish yellow oily liquid without odour, and with a faintly acrid oleaginous taste. It contains 72 per cent. *olein* and 28 per cent. of *palmitin.*

Dose—½ to 1 fl. oz.—15 to 30 mils.

Unguentum Aquosum.—Hydrous Ointment. Contains 50 per cent. of olive oil, 12·5 percent. of white beeswax, 12·5 per cent. of white soft paraffin, 1 per cent. of borax and 24 per cent. of distilled water.

ACTION AND THERAPEUTIC USES

External.—Olive oil is used as a protective to the skin and as an emollient to render it smoother, softer and more flexible. As a lubricant, it is used to facilitate massaging. When rubbed into the skin, it is absorbed by the lymphatics and affords a certain amount of nutrition when nourishment cannot be given by the mouth. Infants can be nourished in this way for a short time when the gastro-intestinal tract requires complete rest.

Internal.—Olive oil is used internally for much the same indications as demulcents. It forms a protective coating to the wall of the stomach and intestine, and, acting as a lubricant, it produces a laxative effect, before it is absorbed. After absorption, it has a nutritive effect. In the stomach, it has the peculiar property, which is common to fixed oils, of reducing the secretion of gastric juice as well as its acidity, and olive oil is largely given for this purpose in gastric ulcer and in hyperchlorhydria. On the basis of laboratory experiments where gall stones placed in olive oil got slowly dissolved, olive oil is used as a remedy for gall stones. But it is believed to have no such action in the body and its usefulness in jaundice is due to its stimulating the secretion of the pancreatic fluid and the flow of bile. Olive oil may be given by an enema in cases of fæcal impaction.

Olive oil as a food.—Olive oil enters the blood through the lacteals and lymphatics; and it is carried to the different cells of the body, where it is fully oxidised into carbonic acid and water to produce the necessary force and energy. It thus saves the fat and waste of nitrogenous tissue, but in itself it is unable to support life, as it is not stored up in the body to be utilised for future needs. Besides, the vegetable oils do not contain the fat soluble vitamin (vitamin A) which is necessary for promoting growth.

COTTON SEED OIL

Oleum Gossypii Seminis.—The oil expressed from the seeds of various cultivated species of *Gossypium*. It occurs as a pale-yellow or yellow oil, nearly odourless, and with a bland taste. It resembles olive oil in all respects and may be used as a substitute for it.

Dose—½ to 1 fl. oz.—15 to 30 mils.

ALMOND OIL

Oleum Amygdalæ.—It is a fixed oil expressed from the sweet or bitter seeds of *Prunus Communis Dulcis* or *Amara*. It has the same characteristics and uses as olive oil, but it is said to be more nutritive.

Dose—½ to 1 fl. oz.—15 to 30 mils.

ARACHIS OIL

Oleum Arachis. *Synonyms.*—Earth-nut oil; Ground-nut oil: the oil expressed without heat from the seeds of *Arachis Hypogæa.* It is a pale-yellow or greenish-yellow liquid, having a nut like odour. It has the same action and uses as olive oil, and is allowed to be so used in India. African, Eastern and Australasian Colonies use it as a substitute for olive oil in official preparations.

Dose—½ to 1 fl. oz. —15 to 30 mils.

SESAME OIL

Oleum Sesami.—The oil expressed from the seeds of *Sesamum Indicum.* Like arachis oil it is also used as a substitute for olive oil in official preparations.

Dose—½ to 1 fl. oz.—15 to 30 mils.

SOAP

Sapo Durus.—Hard Soap. *Synonyms.*—Castile Soap. Sodium Oleate. It is prepared from olive oil and sodium hydroxide. It occurs as a whitish solid or a fine yellowish-white powder.

Sapo Mollis.—Soft Soap. *Synonym.*—Potassium Oleate. It is prepared from olive oil and potassium hydroxide. It occurs as a soft unctuous yellowish brown mass.

Linimentum Saponis. *Synonym.*—Opodeldoc. An alcoholic solution of 8 per cent. soap, .4 per cent. camphor, 1·5 per cent. oil of rosemary and 17 per cent. of water.

ACTION AND THERAPEUTIC USES

Soaps are **emollients** and cleansing agents. They dissolve all sebaceous secretion, soften and remove scales and crusts, and facilitate epilation. They have a slight **antiseptic** action. Washing the hands in strong suds for 5 minutes will destroy most of the pathogenic organisms. Hard soap forms the basis of medicated soaps, and is mainly employed in making pills, plasters, liniments and in the preparation of purgative enema in cases of impaction of fœcal matter in colon or rectum. It forms also a basis for dentifrices, both powdered and liquid. Its antiseptic action, is far more than the soft soap owing to the excess of alkali in it.

CURD SOAP

Sapo Animalis.—Curd Soap. *Synonym.*—Sodium Stearate. Soap made with sodium hydroxide and purified animal fat consisting principally of stearin contains not less than 30% of water.

It is contained in Extractum Colocynthedis Compositum.

Action and Therapeutic Uses

Curd soap, like hard soap, is employed as a basis for pills, plasters and liniments, and may be used for medicated soaps.

OIL OF THEOBROMA

Oleum Theobromatis. *Synonym.*—Cacao butter. A solid fat obtained by expression from the seeds of *Theobroma cacoa.* It occurs as a yellowish white solid, having a faint agreeable odour and a bland chocolate-like taste. It does not become rancid by exposure to air and has a melting point of 30° to 35° C. It contains *Stearin, Olein* and an alkaloid, *theobromine.*

Action and Therapeutic Uses

Its main use in medicine is for the preparation of medicated suppositories and bougies. Since its melting point is lower than the body temperature, any solid or semisolid medicament may be incorporated with it, and will be liberated by its melting when introduced into the rectum, vagina or urethra. It may, however, be used as an emollient and protective to the skin burned by the sun or roughened by cold and wind.

OLEIC ACID

Acidum Oleicum. *Synonym.*—Hydrogen Oleate. Obtained from fats or fixed oil by the saponifying action of alkalies and the subsequent action of acids, or by the action of superheated steam. It is a straw-coloured, oily liquid, having a peculiar lard-like odour and taste.

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION AND THERAPEUTIC USES

Oleic acid as it penetrates the skin more readily than fats and oils, is used as a solvent and vehicle for remedies which are to be applied by means of cutaneous innunction. It dissolves most of the metallic oxides and all alkaloids (not their salts) forming oleates, some of which are official. It is given internally in capsules for gall stones. It acts like olive oil.

GLYCERINE

Glycerinum.—Glycerine. *Synonym.*—Glycerol. It is a trihydric alcohol associated with a small percentage of water. It is obtained by the hydrolysis of fats and fixed oils. It is a clear, colourless, syrupy liquid, having a sweet taste, which is followed by a sensation of warmth. It is miscible with water and with alcohol. It is powerfully hygroscopic, and neither evaporates nor turns rancid.

Incompatibles.—Oxidising agents with glycerine form explosive compounds.

Dose—1 to 2 fl. drs.—4 to 8 mils. by the mouth.
½ to 2 fl. drs.—2 to 8 mils. by rectal injection.

1. **Glycerinum Acidi Borici.**—It is a 30 per cent. solution of boric acid with the aid of gentle heat.

Dose—10 to 30 ms.—0·6 to 2 mils.

2. **Glycerinum Acidi Tannici.**—15 per cent. tannic acid.

Dose—10 to 30 ms.—0·6 to 2 mils.

3. **Glycerinum Amyli.**—It is a solution of starch in glycerine and water made to the consistency of a jelly by gentle heat.

4. **Glycerinum Aluminis.**—13 per cent. potash alum.

Dose—30 to 60 ms.—2 to 4 mils.

5. **Glycerinum Phenolis.**—20 per cent. phenol.

Dose—5 to 15 ms.—0·3 to 1 mil.

6. **Glycerinum Boracis.**—12 per cent. of borax.

Dose—30 to 60 ms.—2 to 4 G.

7. **Suppositorum Glycerini.**—Each suppository contains about 70 per cent. of glycerine with gelatin as the base.

Glycerine is also used in making Mel Boracis, all the Lamellæ and many other preparations.

ACTION OF GLYCERINE

External.—Much of the local action of glycerine is referable to its hygroscopic property. Pure glycerine on the unbroken skin is an **irritant** and an **antiseptic.** Its irritant action is more marked on the raw surfaces, as manifested by the burning pain for a time, but then it acts as an **emollient** and a **protective.**

Internal.—On the mucous surfaces, it abstracts water from them, helps the penetration of drugs dissolved in it, and is a demulcent. It is, therefore, largely employed as a vehicle for substances used in affections of the skin and accessible mucous membranes. In small doses, it has very little systemic effect. In the stomach, it acts as a **demulcent.** It is readily absorbed from the bowels and is burnt in the body. It thus acts as a food, which spares fat but does not reduce protein metabolism. As it reduces the amount of sugar in the urine of certain diabetic patients, it may be having effect on the amount of glycogen in the liver. Glycerine in the form of a small enemata or suppository exerts its local irritant action, induces peristalsis and causes a prompt evacuation of the lower bowel within less than half an hour; but its constant use is to be avoided as it may lead to the inflammation of the rectum. Placed in cervix uteri, glycerine causes uterine contraction by its irritant effect.

THERAPEUTIC USES

As an emollient, glycerine is used for chapped hands, cracked lips, chilblains, eczema and prurigo. It is largely used as a basis for cosmetic preparations; and it is a good solvent for antiseptics and other drugs to be applied to the throat, urethra and vagina. Glycerine is a useful remedy in constipation due to the inertia of the lower bowels, but it must be injected into the rectum in quantities varying from 2 drachms to one ounce. In children the glycerine suppositories should be used. Owing to its hygroscopic property, it is largely used to reduce inflammation of the mucous cavities. Glycerine soaked tampons are therefore largely used to relieve congestion or subacute inflammation of the vagina, uterus or tubes. Mixed with water, it softens ear-wax or cerumen and facilitates its removal without injury to the internal parts of the ear.

SUET

Sevum Preparatum.—Prepared Suet. The purified internal fat of the abdomen of the Sheep, *Ovis Aries*; it contains 30 per cent. of the *olein* with *palmitin* and *stearin*. *It is contained in* Unguentum Hydrargyri.

ACTION AND THERAPEUTIC USES

It is used externally as an emollient.

LARD

Adeps. *Synonym.*—Adepts Preparatus ; Prepared Lard. The purified internal fat of the hog *Sus Scrofa.* It occurs as a soft, white, homogeneous, unctuous substance, having a faint odour. It contains 60 per cent. of *olein* with *stearin* and *palmitin.*

Adeps Benzoinatus.—Lard prepared with benzoin to prevent rancidity.

Adeps Lanæ.—Wool fat. *Synonym.*—Anhydrous Lanoline. The purified fat of sheep's wool freed from water. It occurs as a yellowish, tenacious, unctuous substance having a characteristic odour.

It is contained in Emplastrum Cantharidini.

Adeps Lanæ Hydrosus.—Hydrous Wool Fat. *Synonym.*—Lanolin. It consists of wool fat into which 25 per cent. of water is incorporated.

ACTION AND THERAPEUTIC USES

Lard is a simple emollient forming the basis of many of the official ointments. Hydrous wool fat is a basis for volatile substances or drugs to be absorbed through the skin, as the penetration of hydrous wool fat is greater and quicker than any other fat.

WAX

Cera Flava.—Yellow Beeswax. It is prepared from the honeycomb of hive bee, *Apis Mellifica.* It occurs in a firm yellowish mass, soluble in turpentine but not in alcohol.

Cera Alba.—White Beeswax. Made by bleaching yellow beeswax.

Unguentum Aquosum.—Hydrous ointment. Contains white beeswax, white soft paraffin, olive oil, borax and distilled water.

ACTION AND THERAPEUTIC USES

Yellow and white beeswax are only used as bases for plasters and ointments.

PARAFFIN HYDROCARBONS

1. **Paraffinum Durum.**—Hard Paraffin. It is a colourless or white, more or less translucent, crystalline mass, which melts between 50° and 60° C. It is without odour or taste and is slightly greasy to touch ; insoluble in water or alcohol, but freely soluble in ether and chloroform.

2. **Paraffinum Liquidum.**—Liquid Paraffin. It is a colourless, transparent, viscous liquid with neither taste nor odour.

Dose—¼ to 1 fl. oz.—7·5 to 30 mils.

3. **Paraffinum Liquidum Leve.**—Light liquid paraffin is a transparent, colourless oily liquid. It is insoluble in water.

4. **Paraffinum Molle Album.** *Synonym.*—White vaseline. A white, translucent, unctuous mass free from any odour or flavour. Insoluble in water or alcohol.

5. **Paraffinum Molle Flavum.** *Synonym.*—Yellow Vaseline. A pale yellow translucent soft unctuous mass free from odour or taste. Insoluble in water and in alcohol.

1. **Unguentum Paraffini.**—A mixture of soft white or yellow paraffin with hard paraffin and beeswax.

2. **Unguentum Simplex.**—A mixture of soft white or yellow paraffin with hard paraffin and wool fat.

ACTION AND THERAPEUTIC USES

Paraffins, according to the method of preparation occur in various consistencies, either solid, soft or liquid. They resemble fats in their physical characteristics and therapeutic uses, but their advantage over them lies in not becoming rancid, not undergoing deterioration and in not being acted upon by acids or other oxidising agents. Their disadvantages are that they are not absorbed through the skin and are therefore unsuitable as a bases for ointments, and they are not nutrients.

Hard Paraffin—is mainly used to give stiffness to ointments. It is of late used in the treatment of burns and in cosmetic operations for mending a deformed part.

Soft Paraffin—acts as an emollient and is used as a basis for ointment. But as its melting point is low, when applied to the skin, it melts and trickles away from the part to which it is applied. It is, therefore, often mixed with hard paraffin to give hardness to it.

Liquid Paraffin—is used externally, either alone or as a vehicle for antiseptics or other medicaments, for an application to the respiratory mucous membrane for the relief of acute or chronic inflammation. It is either painted or sprayed by means of an atomizer. Internally, it is used for its **laxative effect,** but not being easily absorbed, it percolates through the intestines and acts as a mechanical lubricant facilitating the passage of the intestinal contents through the small and large bowels. Its disadvantage is that if given in large quantities it leaks through the anal sphincter and soils the underclothing. No definite dose could be assigned to it. One must experiment on oneself to arrive at the suitable dose ; generally, it is commenced with a dose of half an ounce.

Light Liquid Paraffin—is suitable for the preparation of nebulæ and sprays.

SWEETENING AGENTS

SUCROSE

Sucrosum. *Synonym.*—Saccharum Purificatum. Refined Sugar ; Cane Sugar. A crystallized sugar obtained from the juice of sugarcane, sugar beet and other plants. It is freely soluble in water and increases the solubility of lime in water as in Liquor Calcis Saccharatus.

Syrupus.—Nearly 67 per cent. dissolved in water with the aid of heat.

ACTION AND THERAPEUTIC USES

Sugar is a nutritive and demulcent. It is used as a preservative. In pharmacy, sugar is chiefly used as a sweetening agent, to render oils miscible with water, to give consistency to pharmaceutical preparations, and to prevent certain ferruginous preparations from oxidation.

LIQUID GLUCOSE

Glucosum Liquidum.—It is obtained by incomplete hydrolysis of starch and consists of a mixture of dextrose, maltose dextrin and starch. It occurs as a colourless viscid liquid without any odour and has a sweet taste. It is freely soluble in water.

Syrupus Glucosi Liquidi.—50 per cent. in simple syrup. Mixed by the aid of gentle heat.

ACTION AND THERAPEUTIC USES

Glucose is a rapid and powerful nutrient and renders valuable service as an emergency food in cases of gastric ulcer, recurrent vomiting, starvation and wasting diseases. In the strength of 5 per cent. solution in physiological salt solution, glucose can be administered by subcutaneous, intravenous or rectal injection in cases of collapse, to prevent surgical shock, to treat delayed chloroform poisoning, in hypoglycæmia of insulin treatment and to increase the secretion of urine.

LÆVULOSE

Lævulosum. *Synonym.*—Fructose. It is prepared from invert sugar or from honey. It consists chiefly of lævulose together with small quantities of dextrose and water.

ACTION AND THERAPEUTIC USES

It is a sweetening agent prescribed only to diabetic patients when they cannot tolerate any other carbohydrate.

SUGAR OF MILK

Saccharum Lactis.—Sugar of milk. *Synonym.*—Lactose. A crystallised sugar obtained from the whey of milk. It occurs in white, hard, crystalline masses or as a white powder, producing a gritty sensation on the tongue. It is faintly sweet in taste and is not hygroscopic.

ACTION AND THERAPEUTIC USES

Sugar of milk is used as a vehicle for the trituration of powders, because of its hardness which thoroughly divides them. It is also used as a diluent in pharmacy to get the required strength of a drug. It is an ingredient of many infant foods, both commercial and extemporaneous preparations. Sugar of milk is a **mild laxative** in large doses taken in a glass of warm milk or cold water on rising in the morning.

SOLUBLE SACCHARIN

Saccharinum Solubile.—It is a sodium derivative of oxybenzoic sulphinide. It is a white crystalline powder with a faint aromatic odour. Taste intensely sweet. It is about 300 times sweeter than cane sugar and is a coal-tar derivative.

ACTION AND THERAPEUTIC USES

It is the sweetest of the known substances. Though **sweet in taste, it is not a food like sugar, nor a medicine,** as it has no special effects on the system, except perhaps the one of checking the secretion of the gastric juice and retarding the digestion when taken in large quantities. It is absorbed readily and excreted almost wholly in the urine. It is used as a sweetening agent when sugar is prohibited as in diabetes. Commercially, it is used to sweeten beverages, prepared foods and proprietary medicines.

COLOURING AGENT

COCHINEAL

Coccus.—Cochineal. The dried, fecundated insect, *Coccus Cacti*. Its chief constituent is a glucoside *carminic acid.*

Tinctura Cocci.—10 per cent. in alcohol (45 per cent.).

Dose—5 to 15 ms.—0·3 to 1 mil.

Cochineal is contained in the compound Tinctures of Cardamom and Cinchona.

GROUP XI

VITAMINS AND NUTRIENT MATERIALS

Vitamins, Halibut-Liver Oil, Cod-Liver Oil, Malt

VITAMINS

Vitamins A, B1, B2, C and D are official.

Vitamins are chemical bodies of unknown composition found in very minute quantities in our food-stuff. They are produced only in plants and pass into the system directly with the vegetable food and fruits, and indirectly with the animal food. They are essential for maintaining a healthy constitution. Their purpose is to control the utilization of the other food-stuffs, namely, proteins, carbohydrates, fats, minerals and water. A well-balanced diet of proteins, fats and carbohydrates with lack of vitamins in it produces certain diseases such as rickets, beri-beri, pellagra, scurvy and others. They are known as deficiency diseases. Nothing definite is known about their action. They are probably stored in our body to influence normal metabolism by oxidation. They act as catalysts—like hormones—unlike hormones vitamin are not generally synthesized in the body. They are natural food medicines acting as prophylactic and curative. A good many vitamins are isolated from our food-stuff but the composition of only six of them is found out and these are prepared synthetically.

When the properties of the Vitamins were first studied and their chemical compositions were not fully determined, it was customary to name these recognised ones as A, B, C, D and E. Even at present for the sake of convenience, they are so named. As we learn more about them, the vitamins are being given distinct chemical names like other compounds. When a complex vitamin is isolated in several factors, it is designated by addition of a numeral to its name, such as B1, B2, B3, and so on.

At present Vitamins are classified into five groups :—

(U. S. Vita. Corp.)

1. Nitrogenous Vitamins: B1, B2 (G), B3, B4, B5, B6, and Anti-anæmia Substance.
2. Sterol group (fatty alcohols): the Vitamin D complex and Vitamin E.
3. Sugar derivatives : Vitamin C.
4. Carotene derivatives : Vitamin A.
5. Unsaturated fatty acids : Vitamin F.

VITAMIN A

Vitamin A. *Synonyms.*—Avoleum, vogan. It is elaborated in the animal body from the characteristic corotenoid pigment, B—Carotene and its isomers. It is stored up in the fatty tissues of animals. It is found richly in whole milk, cream, butter, beer, yolk of an egg, liver-oils of Cod and halibut spinach and water-cress. It is absent from lard and vegetable fats.

Symptoms of deficiency.—In animal experiments, deficiency of Vitamin A retards growth and lowers resistance of the body to bacterial infections, and increases susceptibility to affections of lungs, skin and glands. It causes xerophthalmia and night blindness and aids in the formation of phosphatic calculi.

Liquor Vitamini A Concentratus.—Concentrated solution of Vitamin A. It is a solution of Vitamin A in a suitable fish-liver oil or vegetable oil, such as Arachis oil. It contains in 1 gramme 50,000 units of Vitamin A.

Dose—1 to 5 ms.—0·06 to 0·3 mil.
(2,500 to 12,500 units). Vitamin A.

Liquor Vitaminorum A et D Concentratus.—Concentrated solution of Vitamins A and D. (*See* Vitamin D.)

Oleum Hippoglossi.—Halibut-liver oil. It is a fixed oil obtained from the fresh liver of the halibut, Hippoglossus vulgaris. It is a pale yellow with fishy odour and taste. Halibut-liver oil contains in each gramme not less than 30,000 units of Vitamin A activity. It is slightly soluble in alcohol, miscible with ether, with chloroform and with light petroleum. It should be protected from light.

Dose—1 to 5 ms.—0·06 to 0·3 mils.
(1,500 to 7,500 units). Vitamin A.

ACTION AND THERAPEUTIC USES

Vitamin A is essential for maintaining the integrity of the epithelial linings throughout the body—its first line of defence against infective organism ; and to preserve structure and function of the cutaneous system. Thus Vitamin A is prescribed for prevention and treatment of acute infections, particularly those affecting the mucous membranes of the upper respiratory tract—the nose and para nasal sinuses. It is of value, therefore, in the treatment of such acute conditions as influenza, tonsillitis and the common cold.

VITAMIN B

Vitamin B Complex.—It contains a number of different related vitamins several of which at present have an undetermined nomenclature, composition and value. Vitamin B factors are available richly in the germ and outer layers of cereals and peas, in yeast, eggs, fish and to some extent in all natural food-stuffs and vegetable. At present two factors of Vitamin B complex are official. (1) Vitamin B1 or heat labile component ; (2) Vitamin B2 or heat stable component. They are synthesized under the official names of Aneurin Hydrochloride and Nicotinic Acid respectively.

Aneurinæ Hydrochloridum. *Synonyms.*—Vitamin B1 Betaxin, Benerva, Ryzamine, Aneurin, Torulin, Antineuritic Vitamin, Thiamine chloride. It may be obtained from rice polishings, yeast and other natural sources or by synthesis. It occurs in colourless plates with odour and taste, bran-like. It is readily soluble in water.

Dose—$\frac{1}{200}$ to $\frac{1}{100}$ gr.—0·0003 to 0·0006 G. Prophylactic (daily) **(100 to 200 units).**

$\frac{1}{100}$ to $\frac{1}{83}$ gr.—0·0006 to 0·0018 G. Therapeutic (daily) **(200 to 600 units).**

Pulvis Vitamin B1 (official).—It is an adsorbate of Vitamin B1. It is a preparation of fuller's earth upon which the Anti-neuritic factor of Vitamin B1 has been adsorbed.

It is a cream coloured tasteless powder, insoluble in water. It contains in 1 gramme 100 units of Anti-neuritic activity (Vitamin B1).

Dose—15 to 30 grs.—1 to 2 G. Prophylactic daily dose.
(100 to 200 units).
30 to 90 grs.—2 to 6 G. Therapeutic daily dose.
(200 to 600 units).

Symptoms of Deficiency.—In animal experiments the lack of Vitamin B1 is manifested in anorexia, faulty metabolism, cardio-vascular disorders, polyneuritis, stoppage of growth and fall in weight. In man, its deficiency causes Beri-beri with concomitant disorders of digestion cardio-vascular system and the nervous system. Two forms of Beri-beri are known : (*a*) the " Wet " in which the cardio-vascular symptoms predominates to cause œdema and dropsy. The other (*b*) " Dry " in which the nervous system is chiefly affected so as to produce the symptoms of multiple neuritis.

ACTION AND THERAPEUTIC USES

Vitamin B1 is of considerable importance in that it is concerned in tissue-oxidation and carbohydrate metabolism. In its absence the oxidation does not take place and the intermediate products of carbohydrate metabolism, lactic, pyruvic acids accumulate in the body. In such circumstances the nerve cells fail to function normally. The brady-cardia resulting from the deficiency of Vitamin B1, causes cardiac deficiency and usually elevates venous pressure to cause the œdema characteristic of the " Wet " Beri-beri. Vitamin B1 has a curative and prophylactic value in Beri-beri and is essential for the maintenance of normal growth in infants and children.

Vitamin B2 (G)—The American Biologists called Vitamin B2 as Vitamin G, for that reason both names are frequently employed together. This was at first believed to be a single substance. It is now known that it consists of many factors, out of which three are known :—(1) Lactoflavin (known also as Riboflavin) is a growth-promoting factor. (2) Anti-pellagra factor. (3) Anti-dermatitis (in rats) factor. It is not definitely known which vitamin principle is responsible for pellagra. Some believe that a combination of Lactoflavin and B6 (a vitamin preventive for dermatitis in rat) are effective as a pellagra preventive. At any rate, Nicotinic acid is stated to be a precursor of Vitamin B2 in the body. The symbol B2 is used to refer to this specific vitamin.

Acidum Nicotinicum. *Synonyms.*—Vitamin B2, PP. factor (pellagra-preventing). It is obtained from nicotine by oxidation. It occurs in white crystalline powder, feebly acid taste. Sparingly soluble in cold water, freely in boiling water and in solutions of alkalies.

Dose—¾ to 1½ grs.—0·05 to 0·1 G.

THERAPEUTIC USES

Although the precise nature of the PP. factor is not known, it has been established that the administration of nicotinic acid is effective in curing the complex syndrome included under the term pellagra. The syndrome consists of dermatitis, diarrhœa, stomatitis, nervous and other symptoms.

VITAMIN C

Acidum Ascorbicum. *Synonyms.*—Vitamin C. Redoxon Canton, Cebion. It may be obtained from the ripe fruit of Capsicum Annum and other vegetable sources or by synthesis. It occurs in colourless, odourless crystals with acid taste. Readily soluble in water, less soluble in alcohol (95 per cent.), in methyl alcohol and in acetone. It contains in one gramme 20,000 units of antiscorbutic activity (Vitamin C).

Dose—$\frac{2}{5}$ to $\frac{4}{5}$ grs.—0·025 to 0·5 G. As prophylactic.
(500 to 1,000 units).
1½ to 4 grs.—0·1 to 0·25 G. As therapeutic.
(2,000 to 5,000 units).

Symptoms of Deficiency.—The lack of Vitamin C in the system creates a pathological syndrome which is manifested in a disease scurvy. The syndrome consists of impairment of the normal cellular " Oxidation and reduction " function, degeneration of capillary walls, disordered calcium deposition (particularly in the teeth) and defective blood formation.

ACTION AND THERAPEUTIC USES

The precise mode of action of Vitamin C still remains rather obscure. It is given as a preventive and curative for scurvy of infants and adults in the form of lemon or orange juice. It is now firmly established that the need for Vitamin C increases very considerably during pyrexial state and acute infective conditions as they accelerate the depletion of Vitamin C. It has been found valuable in the treatment of capillary hæmorrhages and arsenical dermatitis. It is given in incipient cataract and anæmia.

VITAMIN D

Liquor Vitamini D Concentratus.—Concentrated solution of Vitamin D. It is a solution of Vitamin D in suitable fish-liver oil or vegetable oil, such as Arachis Oil. It contains in 1 gramme 10,000 units of Vitamin D.

Dose—½ to 3 ms.—0·03 to 0·2 mil. (250 to 1,500 units). Vitamin D.

Liquor Vitaminorum A et D Concentratus.—Concentrated solution of Vitamins A and D. It is a solution of Vitamins A and D in a suitable fish-liver or vegetable oil, such as Arachis Oil. It contains in 1 gramme 50,000 units of Vitamin A, and 5,000 units of Vitamin D.

Dose—1 to 5 ms.—0·06 to 0·3 mil.
(2,500 to 12,500 units). Vitamin A.
(250 to 1,250 units). Vitamin D.

Calciferol. *Synonyms.*—Radiostol, Vitamin D. It occurs in colourless, odourless, acicular crystals insoluble in water, soluble in oils, in alcohol (95 per cent.), in ether and chloroform suitable solvent. It is prepared by ultraviolet irradiation of Ergosterol in a suitable solvent. It contains in 1 milligram 40,000 units of antirachitic activity (Vitamin D).

Dose—$\frac{1}{2,400}$ **to** $\frac{1}{1,200}$ **gr.—0·025 to 0·05 G.** As a prophylactic dose.
(1,000 to 2,000 units).
$\frac{1}{1,200}$ **to** $\frac{1}{800}$ **gr.—0·05 to 0,075 G.** As a therapeutic daily dose.
(2,000 to 3,000 units).

Liquor Calciferolis.—It is a solution of calciferol in a suitable vegetable oil. It contains in 1 mil. about 3,000 units. 15 minims contain about 3,000 units of antirachitic activity.

Dose—5 to 10 ms.—0·3 to 0·6 mil. As a prophylactic daily dose.
(1,000 to 2,000 units). Vitamin D.
10 to 15 ms.—0·6 to 1 mil. As a therapeutic daily dose.
(2,000 to 3,000 units). Vitamin D.

Symptoms of Deficiency.—Lack of Vitamin D produces rickets and defective calcification of the teeth in children and obsteomalacia in adults. It is well known that the pathological process in rickets consists of a softening and consequent deformity of bones due to deficient deposition of calcium phosphate. A similar deficiency of Vitamin D in adults, when the growth of bones has ceased, leads to a general rarification and softening of the skeleton—osteomalacia.

ACTION AND USES

Vitamin D is essential for the proper absorption of calcium and phosphorus. It is now recognised as valuable in the preventive and curative treatment of infantile rickets, spasmophilia and osteomalacia. It also plays an important part in tooth formation and in the maintenance of the normal tooth structure. It exerts a specific action in these conditions by raising the level of calcium and phosphorus in the blood through more complete assimilation from the food. Intake of calcium and phosphorus alone without the absence of Vitamin D does not determine absorption and utilization in the body. The natural source of Vitamin D is the ultra-violet rays of the sun. They by their action on the skin, convert its precursor—ergosterol—in the body into Vitamin D. This source of Vitamin D is normally inadequate and to satisfy the needs of the body a considerable portion is absorbed through the intestine from the food. During those seasons, however, when the actinic value of the sunlight is diminished considerable deficiency of Vitamin is frequently encountered.

Toxicity of Vitamin D (*Hypervitaminosis*).—Excessive dosage of Vitamin D, will produce loss of appetite and weight, general depression and diarrhœa. The hair is greasy and rough. There is calcification of the blood vessels and of the vital organs.

COD LIVER OIL

Oleum Morrhuæ.—A fixed oil obtained from the fresh liver of the cod, *Gadus morrhua*. It is a pale yellow, thin, oily liquid, having a fishy odour and fishy taste. It is slightly soluble in alcohol, and freely soluble in ether and chloroform. It contains a large quantity of free, fatty acids, combined with glycerine, bile constituents, ***unsaponifiable fats***, of which chief is ***cholesterol***, putrefactive alkaloids asellin, ***morrhuine***, traces of iodine, bromine and other impurities. Recent investigations have brought out the fact that it also contains ***vitamins***, particularly A and D, to which the beneficial actions of cod-liver oil are due.

Dose—15 to 30 ms.—1 to 2 mils. Prophylactic thrice daily.
45 to 90 ms.—3 to 6 mils. Therapeutic thrice daily.

Extractum Malti cum Oleo Morrhuæ. (See Malt.)

Emulsio Olei Morrhuæ.—Emulsion of cod-liver oil in proportion of 1 to 2.

Dose—30 to 60 ms.—2 to 4 mils. Prophylactic.
(1,000 to 2,000 units. Vitamin A.
(100 to 200 units). Vitamin D.
90 to 180 ms.—6 to 12 mils. Therapeutic.
(3,000 to 6,000 units). Vitamin A.
(300 to 600 units). Vitamin D.

Oleum Vitaminatum.—Vitaminised oil. It is a solution of Vitamins A and D in a suitable fish-liver oil or vegetable oil, such as Arachis oil. It contains in 1 gramme 1,000 units of Vitamin A and 100 units of Vitamin D. It should be protected from light.

Dose—15 to 30 ms.—1 to 2 mils. Prophylactic.
(1,000 to 2,000 units). Vitamin A.
(100 to 200 units). Vitamin D.
45 to 90 ms.—3 to 6 mils. Therapeutic.
(3,000 to 6,000 units). Vitamin A.
(300 to 600 units). Vitamin D.

Emulsio Olei Vitaminati.—Emulsion of Vitaminised oil in proportion of 1 to 2.

Dose—30 to 60 ms.—2 to 4 mils. Prophylactic.
(1,000 to 2,000 units). Vitamin A.
(100 to 200 units). Vtamin D.
90 to 180 mils.—Therapeutic.
(3,000 to 6,000 units). Vitamin A.
(300 to 600 units). Vitamin D.

Extractum Malti cum Oleo Vitaminato.—Extract of malt with vitaminised oil. (See Malt.)

ACTION AND THERAPEUTIC USES

The action of Cod-liver Oil as a nutrient depends on the bulk glycerides of fatty acids, not found in other fixed oils of vegetable origin, which are easily saponifiable, absorbable and oxidisable. The major portion of the oil is thus utilised in the system, and diminishes, to a certain extent, nitrogenous metabolism. The oil is also absorbed by the skin ; and infants can exclusively be fed in this way for a time. In addition to its nutrient property, it has a specific effect on mineral metabolism. This is probably due to the presence of the vitamins in it. Cod-liver oil restores the normal balance of calcium and phosphorus, which is greatly disturbed in children suffering from rickets, where the excretion of these is out of all proportion to absorption, and as a result the stages of bone formation—osteogenisis—are greatly disturbed. There is excess of cartilage, an insufficiency of lime salts and osteoblasts. The administration of cod-liver oil ensures in such rickety children, an exact and regular supply of these vitamins which stimulate growth and favour calcium retention. It thus acts as a perfect antirachitic medicine. It is given as a routine treatment for tuberculosis in its various local forms and in pulmonary phthisis combined with creosote. It is a very useful fat-forming nutrient in chronic diseases attended with wasting, and in nervous debility where it is given in combination with hypophosphites.

Sodii Morrhua.—Sodium morrhuate is a mixture of sodium salts and of fatty acids obtained from cod-liver oil.

Injectio Sodii Morrhuatis.—A 5 per cent. solution in water containing alcohol and chlorocresol.

Dose—8 to 75 ms.—0·5 to 5 mils. by intravenous injection, as a sclerosing agent.

THERAPEUTIC USES

The use of sodium morrhuate in the treatment of leprosy and tuberculosis has been made with some success. Injections are employed extensively **in the treatment of varicose veins as a sclerosing agent.**

EXTRACT OF MALT

Extractum Malti. *Synonyms.*—Extractum Bynes, Maltine. It is prepared from the malted grain of barley, *Hordeum distichon,* by digesting it with water at a suitable temperature and by evaporating the strained liquid at a temperature not exceeding 55°, until a viscous product is obtained. It occurs as an amber or yellowish brown viscous liquid with an agreeable, characteristic odour and sweet taste. It is miscible with water in all proportions. It contains *maltose* and a *diastase* which converts starch into dextrin and finally to maltose.

Dose—1 to 4 fl. drs.—4 to 16 mils.

Extractum Malti cum Oleo Morrhuæ.—In proportion of 9 to 1.

Dose—1 to 4 fl. drs.—4 to 16 mils.

Extractum Malti cum Oleo Vitaminato.—Extract of malt with vitaminised oil in the proportion of 9 to 1.

Dose—60 to 240 ms.—4 to 16 mils.
(650 to 2,500 units). Vitamin A.
(65 to 250 units). Vitamin D.

ACTION AND THERAPEUTIC USES

Malt is chiefly used as a nutrient and a digestant in persons who are suffering from a wasting disease. It is easily tolerated by the stomach and is generally given in combination with cod-liver oil. It is a valuable food and the ferment in it digests the starches of other foods converting them into maltose. It should, however, be administered some hours after the meal as the ferment is only active in an alkaline medium.

VITAMIN E

Vitamin E (*Non-Official*) is an oil-soluble substance and is extremely stable with regard to high temperatures. Its natural sources, in order of potency, are wheat germ oil, vegetable oils, lettuce, whole grain cereals, legumes and soya-beans. No standard unit has been established.

Symptoms of Deficiency.—It exerts its function on the reproductive system. In the male animal there is gradual degeneration of the germinal epithelium in the testes which is incurable and does not respond to a high Vitamin E diet. Hence the degenerative lesion is called irreversible. There is loss of sperm and a loss of sex interest. In female animals there occurs intra-uterine death fœtus with subsequent reabsorption or abortion.

Nothing definite is known regarding the mechanism through which this Vitamin brings about its physiological action. Probably Vitamin E either directly stimulates progestin—the hormone contained in the corpora lutea—whose function is to prepare the endometrium for the reception and development of the fertilised ovum, or indirectly stimulates the hormone contained in the anterior pituitary which is supposed to motivate the production of progestin by the corpora lutea.

GROUP XII

DRUGS INFLUENCING METABOLISM

Thyroid Gland, Insulin, Liver Extracts, Colchicun, Cinchophen.

THYROID GLAND

Thyroideum. *Synonym.*—Thyroideum Siccum. Dry Thyroid. Thyroid gland. A powder prepared from the fresh and healthy thyroid gland of a sheep. It occurs as a dull brown powder with a faint meat-like odour and taste. The active principle of the gland is *Thyroxine.* It is in colloidal form and is not acted upon by acids or digestive ferments. Chemically, it is a phenyl ether of amino acid tyrosine containing four iodine atoms.

Dose—½ to 5 grs.—0·03 to 0·3 G.

Thyroxin-Sodium. *Synonym.*—Thyroxine. It is a disodium salt of thyroxin. It occurs as a white crystalline powder, sparingly soluble in cold water, more soluble in solution of sodium carbonate and of sodium hydroxide. It contains about 65 per cent. of iodine.

Dose—$\frac{1}{640}$ to $\frac{1}{64}$ gr.—0·0001 to 0·001 G.

ACTION OF THYROID GLAND AND THYROXINE

Absorption and Elimination.—Thyroid is absorbed into the system by the gastro-intestinal tract and its active principle, for all practical purposes, is not destroyed in the body (the destruction being 0·2 to 0·5 milligrammes), nor does it undergo any change to produce its systemic effects. It, however, induces chemical changes in the cells of the body to profoundly affect the metabolism, and the circulatory and nervous systems. It is excreted mainly by the kidneys.

Metabolism.—Continuous administration of thyroid to a normal individual **increases basal metabolism** to a great extent. There is increase in the **destruction of tissue proteins** with consequent increase in the urea, uric acid, sulphur and phosphates of the urine. **Fats and carbohydrates are destroyed to a far greater extent,** and thus there is an increase in the absorption of oxygen and excretion of carbon dioxide. There is profuse diuresis due to the increased excretion of urea acting by salt action. The ability to assimilate sugar is lessened and hyperglycœmia and glycosuria result. In large or toxic doses of thyroid, the metabolism is so rapid that it has to draw upon the body tissues to replenish the waste, and in consequence there occurs a rapid loss in weight. The ratio of destruction between proteins and fats and carbohydrates in the body is generally in the proportion of 1 : 6. The loss of nitrogen, however, is not controlled by increasing the carbohydrates as in starvation, but is controlled by feeding with excess of proteins. Congenital deficiency of thyroid leads to failure of physical and mental development such as occurs in cretinism. Its atrophy or extirpation in adults leads to the condition of myxœdema which is manifested by coarse scaly skin, tendency to adiposity, deposition of a peculiar firm tissue under the skin, low temperature, low metabolic activity, lowered sexual capacity and loss of hair. All these are greatly helped by the administration of thyroid or its active principle, which regulates the cell metabolism and makes it run on normal lines.

Circulatory System.—Continuous feeding with thyroid or its excessive secretion in the body accelerates the heart. The pulse rate rises. There is palpitation and weakening of cardiac beat but the blood pressure remains unaffected and the blood shows increase in the number of lymphocytes.

Nervous System.—Associated with these circulatory effects, produced by large doses of thyroid, there is headache, wandering pains, tremors and great muscular weakness, slight pyrexia and rarely, delirium. There is dilatation of the pupil, retraction of the upper eyelid and protrusion of the eye ball—the effects of sensitization of the sympathetic nervous system. These circulatory and nervous effects are grouped under the heading of **thyroidism**—poisoning by thyroid extract—and are seen in Grave's Disease or Exophthalmic goitre, a disease in which there is hypersecretion from the gland.

THERAPEUTIC USES

Therapeutically, thyroid is employed to supplement the normal thyroid secretion when it is deficient in such diseases as myxœdema and cretinism. It is also given as an antifat measure to reduce obesity, but it should be used with caution, as it also causes protein breakdown. Benefit sometimes follows its administration in various defects of nutrition, such as premature loss of hair, delayed union of fractures and general loss of energy. Thyroid may also be used in certain dry, scaly diseases of the skin, and in cases of arterial hypertension and sclerosis.

INSULIN

Insulinum.—It is a preparation containing the specific antirachitic principle of the mammalian pancreas. It is elaborated by the islets of Langerhans and occurs as a colourless liquid, which is free from turbidity or deposit. Its chemical composition being not yet known, the physiological potency of it is measured in term of units. The standard of insulin unit, as at present in use, is one-third the amount required to reduce the normal blood sugar to 0·045 per cent. in a 2 kilograms rabbit which has been starved for 24 hours. Insulin is always administered by subcutaneous injection as its activity is destroyed by digestive ferments.

Dose—5 to 100 units.

Tabella Insulini.—Prepared by mixing dry insulin powder with a neutral powder such as lactose and compressing the mixture. The number of units in each tablet is mentioned on the container.

ACTION AND THERAPEUTIC USES

The administration of insulin profoundly affects carbohydrate metabolism; all its other effects are only secondary to this. The physiological function of insulin in a normal individual is to enable the tissues (1) to burn sugar, (2) to help the liver and muscles to store sugar absorbed from the intestine as glycogen and (3) to inhibit sugar formation from protein in the liver. The deficiency of insulin secretion, from any cause, upsets this sugar metabolism, and causes excess of sugar to be retained in the blood and eliminated in the urine as is seen in persons suffering from diabetes. The administration of insulin to diabetics once more restores the capacity of the tissues to take up and metabolise the carbohydrates, and the urine becomes free from sugar. Owing to the increase in carbohydrate metabolism produced by insulin, the fat metabolism is also augmented. This causes the removal of the lower fatty acids (butyric, B. hydroxy-butyric and caproic), from the blood and thus the condition of acidosis is counteracted which helps the ketone bodies (aceto-acetic acid) to disappear from urine, the accumulation of which causes diabetic coma. It, however, cures the complaint; and to be of use, its administration must be continuous and regulated according to the severity of the complaint and the amount of carbohydrates ingested. It is best given 15 to 30 minutes after meals. **1 unit of insulin approximately metabolise 2 grammes of sugar.**

Toxic effects.—In large doses, insulin not only reduces the excess of sugar in the blood but reduces even its normal amount, and if the fall be below 0·07, it causes hypoglycœmic reaction, which is manifested by a sense of weakness and fatigue with anxiety and loss of self-control. There is a feeling of tremulousness, pallor and flushing, chilliness and sweating. If the patient is neglected at this stage, he might pass on to the state of unconsciousness or coma. These symptoms are, however, readily controlled by the administration of glucose either by mouth or by injection, or by injections of Adrenaline or Pituitrin and the patient soon regains his normal self. Adrenaline acts by mobilizing the liver glycogen and pituitrin by antagonizing the action of insulin in the tissues. After the administration of insulin, the patient should be warned to take ordinary cane-sugar at the first manifestation of these symptoms.

Protamine Insulin (*non-official*). *Synonym.*—Insulin Retard. Is a combination of insulin with mono-protamine obtained from the sperm of a trout. It was developed by Hagedorn to counter-act the defects of insulin. The major drawback to the use of insulin has been its prompt but transient effect and the consequent necessity for frequent injections. In practice, insulin immediately prior to its use is mixed with the protamine solution to which is added an alkaline buffer solution containing sodium phosphate. A colloidal precipitate forms in the liquid and it contains the active insulin in combination.

Protamine-Zinc Insulin.—The disadvantage of having to mix the insulin and protamine solution before each injection is overcome by this new product which is supplied in the form in which it is used. The addition of zinc to protamine insulin not only augments its action but retards still further the liberation and absorption of insulin from the compound.

ACTION AND USES

Protamine Insulin compound are relatively insoluble, painless on injection and are not followed by any reactions suggestive of protein shock. They are absorbed slowly and the fall in the blood sugar is gradual and persists for a longer time than after ordinary insulin. Ordinary insulin exerts its maximum effect from two to three hours after injection and ceases to be active after about six hours. Protamine insulin is active for fourteen to twenty hours and reaches its maximum effect six hours after injection. While Protamine-Zinc Insulin continues to exercise its effect for nearly twenty-four to thirty hours and shows its greatest benefit in ten to fifteen hours. The possibility of hypoglycœmia arising out of cumulative properties of these slowly absorbed compounds can be guarded against if the injections are judiciously spaced. They are contra-indicated in diabetic coma and clinical acidosis.

LIVER EXTRACTS

Extractum Hepatis Liquidum.—Liquid extract of liver, It is a selected fraction of an alcoholic extract of ox or sheep liver, dissolved in a mixture of glycerine, alcohol and distilled water. One fluid ounce contains the equivalent of 8 ozs. of fresh liver.

Dose—1 fl. oz.—30 mils.

Extractum Hepatis Siccum.—Dry extract of Liver. It is a selected fraction of an alcoholic extract of ox or sheep liver. It occurs as a light brown very hygroscopic powder, with a meat-like odour, and saltish meat-like taste. It is soluble in water. It is kept in glass tubes hermetically closed so as to exclude moisture.

Dose—The quantity equivalent to 225 grammes or about half a pound of fresh liver.

ACTION AND THERAPEUTIC USES

Liver extract is used as a specific for the cure of pernicious anæmia, and the treatment is called Minot-Murphy after its discoverers. Its administration, either orally or by injection brings about a rapid improvement in the condition of the blood. The number of red blood corpuscles, as well as their hæmoglobin content, is increased. The appetite is stimulated and there is improvement in the general condition of the patient. It has also been found to be of use in secondary anæmia and in post hæmorrhagic anæmia, though the results are not so striking as in pernicious anæmia. The exact mode of its action in improving these conditions is not yet known. It probably acts by the stimulation of the bone marrow to provide mature red cells, or by providing a constituent which is essential for the maturation of the normal red blood cells.

COLCHICUM

Colchici Cormus.—Colchicum Corm. The fresh corm of *Colchicum autumnale*, collected in early summer and deprived of its coats, sliced transversely and dried at a temperature not exceeding 65° C. The slices are reniform in outline and without any odour; the taste is bitter and acrid. The activity of colchicum depends on an amorphous, yellowish, bitter alkaloid, *colchicine*.

Dose—2 to 5 grs.—0·12 to 0·3 G.

Extractum Colchici Siccum.—A soft extract made from the fresh corm.

Dose—¼ to 1 gr.—0·015 to 0·06 G.

Colchici Semina.—Colchicum Seed. The dried ripe seeds of *Colchicum autumnale*. The seeds are ovoid, reddish-brown in colour and without any odour; the taste is bitter and acrid. They contain *colchicine* in proportionately larger quantity than corm, and a *volatile oil* in addition.

Dose—2 to 5 grs.—0·12 to 0·3 G.

1. **Extractum Colchici Liquidum.** *Synonym.*—Fluid Extractum Colchici. It is an alcoholic extract containing 0·3 per cent. of colchicine.

Dose—2 to 5 ms.—0·12 to 0·3 mil.

2. **Tinctura Colchici.**—10 per cent. liquid extract in alcohol (70 per cent.). Contains 0·3 per cent. of colchicine or $\frac{1}{250}$ gr. in 15 ms.

Dose—5 to 15 ms.—0·3 to 1 mil.

ACTION OF COLCHICUM

External.—The juice of the corm applied externally to the unbroken skin acts as an **irritant.**

Internal.—*Alimentary Tract.*—The prominent action of colchicum is its slow irritant effect on the gastro-intestinal tract, whether administered by mouth or by injection. In small doses, these effects are rarely seen, but it stimulates the activity of the liver as seen from the increased appearance of bile in fæces. In moderate doses, some hours after its administration by mouth, it causes salivation, loss of appetite, nausea, cramps in the stomach and vomiting. This is, later on, followed by profuse watery evacuations some times tinged with blood, similar to those of cholera and accompanied by symptoms of collapse—great prostration, small thready quick pulse, cold clammy perspiration and slow laboured breathing.

Absorption and Elimination.—The characteristic slow onset of these symptoms is due to the slow absorption and excretion of the drug through the gastro-intestinal tract, stimulating the nerve endings in the glands and the involuntary muscular fibres of the intestines. In this, it resembles pilocarpine in its action. It has been suggested that colchicine, the active principle of the drug in combination with nascent oxygen in the tissues is oxidised into oxydicolchicine, which acts as a more powerful irritant than colchicine. The plain muscular fibres of the spleen, uterus and bronchioles are also affected in the same way. A portion of the drug is also excreted by the kidneys.

Blood.—Colchicum, owing to its irritant effect on the tissues, causes the migration of the white blood cells from the circulation to accumulate in the tissues, especially the marrow ; but very soon, their number in the circulation increases to cause leucocytosis.

Nervous System.—Colchicum, in large doses, after a latent period of some hours, paralyses the central nervous system. The spinal cord is first affected, causing loss of sensation and motor functions. The paralysis of the cord gradually creeps upwards to the respiratory centre in the medulla. Respiration, which is at first deep and full becomes slow and shallow ; and death takes place from respiratory paralysis. The circulatory disturbance is more an effect of gastro-intestinal irritation with no direct cerebral depression. The heart, therefore, continues to beat after death.

Kidneys.—Colchicum in small doses, during its passage through the kidneys, increases the secretion of urine but in larger doses, owing to its irritant action on the renal epithelium, the secretion of urine is checked and there may be albuminuria and hæmaturia. The use of Colchicum as a specific in gout (a disease in which the tissues form an excessive amount of uric acid) is on the supposition that it increases the uric acid excretion from the system ; but the facts proved by experiments do not support the supposition ; nothing definite is known about the way in which it acts as a specific.

Therapeutic Uses

Colchicum is hardly ever used except for gout. In acute cases of this disease, it relieves the pain in the joint, but it does not prevent the recurrence of attacks. It is also used in many other manifestations occurring in persons of gouty diathesis, such as dyspepsia, eczema, neuritis, headache, conjunctivitis, etc. The occurrence of the symptoms of gastro-intestinal irritation is an indication to stop the administration of the drug. It should be always associated with a purge to prevent its accumulation in the body.

CINCHOPHEN

Cinchophenum. *Synonym.*—Quinophan, Atophan, Phenyl quinolin-carboxylic-acid. It occurs as a white or yellowish white crystalline powder, odourless with a bitter taste. Insoluble in water. Soluble in alkaline solutions.

Dose—5 to 15 grs.—0·3 to 1 G.

Action and Therapeutic Uses

The effect of cinchophen, in therapeutic doses, is limited to the uric acid metabolism, and it has no other typical or systemic action. Cinchophen, when administered by the mouth or by injection, **increases the excretion of uric acid** in the urine with a corresponding decrease of uric acid in the blood. It probably acts by lowering the kidney threshold for urates making kidney cells easily permeable to it. Owing to this property of mobilizing uric acid and urates and expelling them out of the system, cinchophen improves acute and chronic manifestations of gout—a disease in which urates are unduly retained in the body. Like other aromatic organic compounds, it acts as an **antipyretic** and **analgesic.** Its continuous administration should be interrupted by periods of rests to avoid overstimulation of the liver, burning sensation in the stomach and urticarial occasionally scarlatiniform eruptions. These effects are however mitigated by giving the drug with a solution of bicarbonate of soda.

GROUP XIII.

DRUGS HAVING ANTIPYRETIC, ANTIPERIODIC AND ANTISEPTIC PROPERTIES

Cinchona Bark, Quinine, Mepacrine, Pamaguin, Salicin, Salicylic Acid, Benzoin.

CINCHONA

Cinchona.. *Synonym.*—Cinchonæ Rubræ Cortex. Red Cinchona bark. The dried bark of the stem and branches of the cultivated plants of *Cinchona Succirubra, Cinchona officinalis* and other species of *Cinchona*. It occurs in quills or curved pieces having a brownish-grey outer surface marked with furrows and ridges. The inner surface is brick-red in colour, and irregularly and coarsely striated. It contains four important alkaloids, *viz., quinine, quinidine, cinchonine, cinchonidine;* two acids, quinic and chinovic; a variety of tannic acid, called cinchotannic acid; cinchona red; and traces of aromatic volatile oil. The official bark must yield 5 to 6 per cent. of total alkaloids of which not less than one half consists of quinine and cinchonidine.

Incompatibles.—Ammonia, Lime-water, Metallic-Salts, Gelatin, and Tannin.

1. **Extractum Cinchonæ.**—An alcoholic extract containing 10 per cent. of the alkaloids of cinchona.

Dose—2 to 8 grs.—0·12 to 0·5 G.

2. **Extractum Cinchonæ Liquidum**.—Standardised to contain 5 per cent. of total alkaloids.

Dose—5 to 15 ms.—0·3 to 1 mil.

3. **Tinctura Cinchonæ.**—10 per cent. in alcohol (70 per cent.) Standardised to contain 1 per cent. of total alkaloids. 30 minims contain ¼ gr. of the total alkaloids.

Dose—½ to 1 fl. dr.—2 to 4 mils.

4. **Tinctura Cinchonæ Composita.**—Contains Cinchona Serpentaria, and Bitter orange peel and is coloured with cochineal. It contains 0·5 per cent. of total alkaloids. 60 ms contain ¼ gr. of the total alkaloids.

Dose—½ to 1 fl. dr.—2 to 4 mils.

5. **Tinctura Cinchonæ Composita Concentrata.**—It has approximately four times the strength of Compound Tincture of Cinchona.

Dose—8 to 15 ms.—0·5 to 1 mil.

Totaquina.—Totaquine is a mixture of alkaloids from the bark of *Cinchona succirubra, Cinchona robusta* and other species of *Cinchona.* It contains not less than 70 per cent. of crystallisable cinchona alkaloids, of which not less than ⅕ is quinine. It occurs as a colourless, or pale yellowish grey, or brown powder without odour, but with a bitter taste. It is insoluble in water, but soluble in alcohol (95 per cent.).

Dose—1 to 10 grs.—0·06 to 0·6 G.

Quininæ Sulphas.—Quinine Sulphate. It is the sulphate of an alkaloid quinine. It occurs as white silky, light, flexible glistening crystals, with an intensely bitter taste. Insoluble in water; but easily soluble in acidulated water from which it can be precipitated by ammonia. The precipitate is soluble in excess of ammonia and in ether.

Dose—1 to 10 grs.—0·06 to 0·6 G.

1. **Ferri et Quininæ Citras.** See Iron (page 66).

Dose—5 to 10 grs.—0·3 to 0·6 G.

2. **Liquor Quininæ Ammoniatus.**—2 per cent. in ammoniated alcohol (60 per cent.).

Dose—½ to 1 fl. dr.—2 to 4 mils.

3. **Syrupus Ferri Phosphatis cum Quinina et Strychnina.** *Synonym.*—Easton's Syrup. Each fluid drachm represents ⅘ gr. of quinine sulphate. (See page 64.)

Dose—½ to 1 fl. dr.—2 to 4 mils.

Quininæ Bisulphas.—Quinine Bisulphate. *Synonym.*—Quinine Acid Sulphate. Bisulphate of an alkaloid quinine. It occurs as colourless transparent or opaque small needles; odourless; taste very bitter; soluble in 10 parts of water, and in 23 parts of alcohol (90 per cent.).

Dose—1 to 10 grs.—0·06 to 0·6 G.

Quininæ Hydrochloridum.—Quinine Hydrochloride. It is the hydrochloride of an alkaloid quinine. Occurs in colourless glistening needles; odourless; and with bitter taste. It is soluble in 32 parts of water and in 2 parts of alcohol (90 per cent.).

Dose—1 to 10 grs.—0·06 to 0·6 G.

Injectio Quininæ et Urethani.—It contains 12·5 per cent. of quinine hydrochloride, 6·25 per cent. of urethane. See urethane. (page 246.)

Quininæ Di-hydrochloridum.—Quinine Di-hydrochloride. *Synonym.*—Quininæ Hydrochloridum Acidum. It occurs as a colourless, odourless powder, with a bitter taste, and is easily soluble in water and in 12 parts of alcohol (90 per cent.).

Dose—1 to 10 grs.—0·06 to 0·6 G. by the mouth.

5 to 10 grs.—0·3 to 0·6 G. by intravenous or intramuscular injection.

Quininæ Tannas.—Quinine Tannate. It is a compound of tannic acid with an alkaloid quinine. It contains about 33 per cent. of anhydrous quinine. It occurs as a pale yellow amorphous powder, with an astringent and a slightly bitter taste. It is sparingly soluble in water, but soluble in alcohol (90 per cent.).

Dose—1½ to 15 grs.—0·1 to 1 G.

Quininæ et Æthylis Carbonas.—Quinine Ethyl Carbonate. It is prepared by the action of ethyl carbonate on quinine. It occurs in odourless and tasteless, fine, soft matted needles. Insoluble in water, but soluble in 2 parts of alcohol (90 per cent.), and readily soluble in dilute acids.

Dose—1½ to 15 grs.—0·1 to 1 G.

ACTION OF CINCHONA AND ITS ALKALOIDS

Cinchona is mainly dependent on quinine for its action. The following description, therefore, will be that of quinine sulphate which is popularly called " quinine."

External.—Quinine is general protoplasmic poisons and, in sufficient concentration, it is fatal to almost all cells. It, however, exerts its powerful action, even in dilute solution, on cells that have an independent movement, such as the white blood cells, spermatozoa, protozoa, ciliated epithelium muscles, etc. For a time it augments their activity but later on paralyses it. In higher concentrations, it destroys bacteria and unorganised ferments also. It thus acts as an **antiseptic** and a **disinfectant.** On a healthy skin, it has very little action, but on raw surfaces, it produces local **irritation** and **anæsthesia.**

Internal.—*Alimentary Tract.*—Quinine, having an intense bitter taste, acts like other bitters, but not so powerfully. Small doses of quinine increase the secretion of saliva, stimulate the gustatory nerves and cause reflex increase in the gastric secretion, which is further augmented by the local action of the drug on the gastric mucous membrane; they also dilate the blood vessels of the stomach, which leads to the increase of gastric secretion, sharpening of the appetite, and improvement of digestion and better absorption of food. It thus acts as a **bitter stomachic** and **tonic.** Large doses of quinine diminish the gastric secretion and may cause loss of appetite, nausea and vomiting. It has practically no action on the intestine except that the small doses of quinine act as a tonic to the muscular coat of the intestine.

Absorption and Elimination.—Given by the mouth, quinine is converted into soluble hydrochloride, and is easily absorbed from the stomach and duodenum. The greater part of the absorbed quinine is destroyed in the body, and the remainder is excreted mainly in the urine. Traces of it are also found in other secretions of the body.

Blood.—Quinine, after reaching its maximum concentration in the blood, causes the total number of white blood corpuscles to diminish; especially there occurs a fall in number of lymphocytes and polymorphonuclears. There may be a primary rise in lymphocytes from the contraction of the spleen. It retards the activity of the intracellular ferments or oxidase, particularly of the blood, and thus interferes with the normal chemical changes of synthesis, oxidation and decomposition. It interferes with the oxygen carrying function of the red blood corpuscles by preventing the decomposition of the oxyhæmoglobin in them.

Metabolism.—Quinine does not affect metabolism in normal people.

Temperature.—Quinine has very little effect on normal temperature, but it decidedly lowers the febrile one. It has, therefore, been suggested that the **antipyretic** action of quinine is possibly the effect of the depressing action of the drug on the thermogenic centre, or it may be due to the toxic action of quinine on the infective agent. Quinine, however, is much less effective as an antipyretic in fevers other than malaria where it is a specific, acting as a direct poison to the plasmodium malariæ which infest the blood to cause the disease.

Nervous System.—In small doses, quinine excites the central nervous system as caffeine does in large doses, or continued maximal therapeutic doses, it produces heaviness of the head, headache, mental confusion, and disturbances of the senses of hearing and sight; ringing noises in the ears, deafness, giddiness and contraction of the field of vision. There is general muscular weakness, apathy and great prostration. The muscular weakness is the direct effect of quinine on the muscles.

Kidneys.—Quinine in small doses stimulates the kidneys during its excretion and acts as a diuretic. In large doses, it may irritate the bladder and urethra, and cause blood to appear in the urine.

Uterus.—As quinine in therapeutic doses causes increased contraction of the involuntary muscles, it is used to promote uterine contractions in labour, and to increase menstrual flow if that is scanty. Larger doses are said to cause abortion—a statement that is doubtful.

Spleen.—Quinine reduces the size of the enlarged spleen of malarial origin. This is probably due to the active contraction of its muscular fibres, and atrophy of the specific elements.

Cinchonism.—Many persons are susceptible to the action of quinine, and in them even small doses of it produce disagreeable symptoms, chiefly in the central nervous system, and they are grouped under the name of Cinchonism. They suffer from ringing noises in the ear, fullness of head, slight deafness, and occasionally eruptions on the skin, of the type of urticaria or erythematous rash. In severe cases of cinchonism, disturbances of vision, giddiness, staggering gait, and intense headache are the prominent symptoms. There may be epistaxis and hæmorrhages.

THERAPEUTIC USES

Cinchona bark is given generally as a bitter stomachic and tonic. Quinine is employed as an antipyretic, but it is inferior to the antipyretics of the coal-tar group. It is mainly used as an antiperiodic to check the recurrence of malarial fevers; and for this purpose, it is best administered in a single large dose of 10 to 15 grs., at least two hours before the attack, and its use should be continued for some time to ensure the complete destruction of malarial parasites. Quinine is also given in splenic enlargement of malarial origin, and in various periodic diseases of the same origin, such as neuralgias. Quinine is useful in coryza, whooping cough and in influenza. In post febrile states, in convalescence from prolonged illness and in conditions of debility, quinine in small doses, is given as a tonic in combination with nux vomica, arsenic and iron. Quinine should not be given to persons suffering from acute disease of the middle ear, or gastro-intestinal irritation, or to persons who are susceptible to symptoms of cinchonism. Bromides and liquid extract of ergot check cinchonism.

Quinidinæ Sulphas.—Quinidine Sulphate. It is the sulphate of an alkaloid quinidine, obtained from the bark of various species of *Cinchona.* It occurs as colourless acicular crystals, with a very bitter taste. It is sparingly soluble in water ; but soluble in 10 parts of alcohol (90 per cent.).

Dose—3 to 10 grs.—0·2 to 0·6 G.

ACTION AND THERAPEUTIC USES

It has the same antipyretic and antiperiodic action as quinine itself, but it has a special effect on certain types of cardiac irregularity. It is used to relieve auricular fibrillations and flutter, in which the regular beats of the auricle are replaced by numerous small irregular beats, starting incoordinately from many parts of the auricle, but too weak to send rhythmic impulses to the ventricle. It acts by increasing the refractory period of the auricular muscles ; and not like digitalis, by diminishing the conductivity of the auriculo-ventricular bundle.

MEPACRINE

Mepacrinæ Hydrochloridum. *Synonyms.*—Atebrin. The drug is a synthetic substance of an acridine-dye nature. It is a yellow, odourless, bitter substance. It is soluble in about 30 parts of water.

Dose—¾ to 1½ grs.—0·05 to 0·1 G.

Mepacrinæ Methanosulphonas.—Mepacrine Methanesulphonate. A yellow, crystalline solid ; odourless with the bitter taste.

Dose—¾ to 1½ grs.—0·05 to 0·1 G. by intramuscular injection.

ACTION AND THERAPEUTIC USES

Mepacrine Hydrochloride has a selective action on the Schizonts (asexual forms) and gametocytes (sexual forms) of benign tertian and quartan malaria. The ring forms and gametocytes disappear within two or three days. The drug frequently causes yellow pigmentation of the skin which usually clears up within about two weeks. There is likely to be much greater toxicity with this compound than with quinine.

Mepacrine Methanesulphonate has similar action to that of Atebrine. The drug is used for injection in cases of severe malaria.

Pamaquinum.—Pamaquin. *Synonyms.*—Plasmochin, Plasmoquine, Beprochin. It is yellow and bitter and insoluble in water.

ACTION AND THERAPEUTIC USES

This drug is used for malaria. The actions are identical but more toxic than with Mepacrinæ hydrochloride. It acts more strongly on the sexual forms. An overdose leads to cyanosis, profuse sweating and cardiac weakness. It should be used with caution in patients with kidney, liver or heart disease or marked anæmia. Occasionally severe symptoms develop suddenly without previous warning.

SALICIN AND SALICYLIC ACID

Salicinum.—A crystalline glucoside obtained from the bark of various species of *Salix* and of *Populus*. It occurs in colourless, silky shining needles or prisms, without odour, but with a very bitter taste. It is soluble in 28 parts of water freely in boiling water, partly soluble in alcohol (90 per cent.) and insoluble in ether and chloroform.

Dose—5 to 15 grs.—·3 to 1 G.

Acidum Salicylicum.—Salicylic Acid. *Synonym.*—Orthooxybenzoic acid. It may be obtained from natural salicylates, such as oils of wintergreen, (gaultheria procumbens) and sweet birch (betula leuta), or by interaction of sodium phenate and carbon dioxide. It occurs in the form of prismatic, colourless crystals, without odour. It has at first a sweetish taste, then acid. It is irritating to the nostrils. It is soluble in 500 parts of water, readily in alcohol, ether and in boiling water and in solutions of alkalies or alkaline salts.

Incompatibles.—Quinine and Spirit of Nitrous Ether.

Dose—5 to 10 grs.—0·3 to 0·6 G.

Unguentum Acidi Salicylici.—2 per cent. in white paraffin ointment.

Bismuthi Salicylas. (See page 182.)

Sodii Salicylas.—Sodium Salicylate. It occurs as white, odourless scales with a saline sweetish taste. It is freely soluble in water and in 6 parts of alcohol (90 per cent.).

Incompatibles.—Hydrobromic Acid precipitates salicylic acid from salt.

Dose—10 to 30 grs.—0·6 to 2 G.

Methyl Salicylas.—Methyl Salicylate. *Synonyms.*—Artificial oil of Wintergreen or Sweet birch. It is the chief constituent of oil of Wintergreen and oil of Sweet birch. It is a colourless liquid, with an aromatic odour and warm sweetish taste. It is almost insoluble in water, but readily soluble in alcohol.

Dose—5 to 15 ms.—0·3 to 1 mil.

Acidum Acetylsalicylicum.—Acetyl Salicylic Acid. *Synonyms.*—Aspirin, Genaspirin. It occurs as a white crystalline powder having slightly acid taste. In contact with moisture it gradually decomposes into salicylic and acetic acids. It is sparingly soluble in water.

Dose—5 to 15 grs.—0·3 to 1 G.

ACTION OF SALICIN AND SALICYLATES

External.—Salicin and Salicylic acid are **antiseptic** and disinfectant like carbolic acid; but owing to their limited solubility and being less volatile, they have a less penetrating power. Like quinine and other aromatic substances, they arrest the activity of cells having independent motion, retards the action of unorganised ferments and arrest putrefaction of all kinds. They are, therefore, used as preservative of substances which are liable to undergo fermentation. Salicylic acid mixed with an inert powder is dusted locally on a part to check excessive sweating. It thus acts as an **anhydrotic.** In concentrated solution, it is a caustic to raw and mucous surfaces and to horny epidermis, which softens and separates without pain and scarring.

Internal.—*Alimentary Tract.*—Salicylic acid is rarely given internally as it is too irritating to the whole of the alimentary tract unless given well-diluted. In the stomach, it gives rise to pain, nausea and vomiting. Salicin and salicylates are much less irritating and of these two salicin is the least irritating. It is the only one of the group which stimulates the gastric secretion and aids digestion by acting as a **stomachic.** In the intestines, the glucoside salicin is converted into glucose and saligenin which is further decomposed into salicylic and salicyluric acids. Salicylic acid and its salts are reputed to be **cholagogues,** increasing both secretion and salts of bile.

Absorption and Elimination.—Salicylic acid and its compounds are rapidly absorbed from the mucous membrane and even from the intact skin when used in the form of ointments. After absorption salicylic acid exists in the blood or tissues as sodium salicylate, from which free acid may be liberated by higher concentration of carbonic acid. It is quickly excreted, mainly in the urine, partly unchanged and partly in combination with glycocoll forming a compound analogous to hippuric acid, called salicyluric acid, which gives a greenish tint to the urine. The rapid excretion of salicylates necessitates large and repeated doses to keep up the therapeutic effects.

Circulatory System.—Small doses of salicylates have very little effect on the heart. Large doses of them by direct action on the muscle of the heart act as cardiac depressant causing considerable slowing of the heart. The blood pressure is primarily increased by the stimulation of the vaso-motor centre, but it soon falls on account of depression of the centre and of the heart. Cutaneous blood vessels are dilated probably by stimulation of the vasodilator centre in the medulla.

Respiratory System.—Nothing marked is seen in small doses. After large doses, the respiratory centre is depressed causing the respiration to become slow, shallow and dyspnœic.

Metabolism.—Salicylates increase nitrogenous metabolism as could be seen in the increase of total nitrogen and sulphur in the urine. The quantity of uric acid, however, is increased to a great extent.

Temperature.—Salicylates have pronounced **antipyretic** effects, in spite of the increased metabolic activity which they induce. Their antipyretic action resembles that of the antipyretics of the coal-tar group, and acting on the heat-regulating mechanism they promote loss of heat by dilating the cutaneous vessels and by profuse sweating. The antipyretic effect of salicylates is particularly well marked in rheumatic fever, where not only the temperature but also the pain in the joints is reduced to a great extent. How they exert this specific effect, which is not equally seen in other fevers, is not known. It may possibly be due to the local antiseptic action of salicylic acid on the causal organism. It is liberated from the tissues by increased carbonic acid tension in the inflamed tissues ; but against this is the fact that the duration of the fever is not materially shortened nor is the danger of the spread of infection to other parts markedly lessened.

Skin.—Salicylates induce copious perspiration and act as **diaphoretics** partly by dilating the cutaneous vessels and partly, as has been suggested, by their central action on the sweat centres. It may cause urticarial or erythematous rash to appear on the body.

Kidneys.—Salicylic acid, as it escapes from the kidneys, exerts a stimulant effect and an antiseptic action on the kidneys and urinary apparatus. It increases the elimination of uric acid in the urine and the uric acid content of blood decreased by lowering of kidney threshold. The appearance of salicyluric acid, as the product of its excretion in the urine, decomposes Fehling's solution and gives a purple colour with perchloride of iron. Large doses irritate the kidneys and cause hæmaturia or albuminuria. It gives a greenish tinge to the urine due to the formation of pyrocatechin and other partially oxidised substances.

Uterus.—Salicylates in moderately large doses are said to increase the menstrual flow and also to cause abortion.

Nervous System.—Small doses of salicylates have very little effect on the nervous system, except that they seem to have a direct action on the sensory nerves or their terminations as analgesia is often noted after their administration in therapeutic doses. But in large doses, or after small doses administered to persons susceptible to its action, they produce a train of symptoms to which the name of **salicylism** is applied. The symptoms closely resemble those of cinchonism. The commonest symptoms are—heaviness and fullness of head, deafness accompanied by ringing in the ears and various disturbances of vision. In spite of these warning symptoms to stop the drug, if the administration is continued, the patient becomes delirious, and suffers from hallucinations of vision and hearing. Respiration becomes dyspnœal in character. The pulse is slow and weak; and the temperature is subnormal. There are hæmorrhages from the nose and kidneys, and urticarial eruptions on the body. The patient dies of cardiac or respiratory failure.

Acetyl Salicylic Acid.—Commonly known as Aspirin is the least irritating compound of salicylic acid when taken internally. Being insoluble in water it does not irritate the stomach. In the intestines, it is split up, by the alkaline contents of the duodenum, into acetic and salicylic acids, and after absorption it produces effects similar to those of salicylates. A portion of aspirin, however, is absorbed unchanged to produce a more powerful **analgesic** and **antipyretic** action than the salicylates, even in non-rheumatic affections. In large doses, it is a cardiac depressant, but rarely produces symptoms of salicylism. In some persons, even in therapeutic doses, it may produce faintness, cyanosis and œdema of the face.

THERAPEUTIC USES

Sodium Salicylate is employed in pyrexia from any cause but it is mainly used as a specific in acute rheumatism; though it is of very little use in chronic rheumatism. It is also given in muscular rheumatism, gout, influenza, diabetes, tonsillitis, and in certain skin diseases probably of rheumatic origin. The solution of Sodium Salicylate is nowadays injected into varicose veins to induce sclerosis. Salicin is sometimes preferred for the treatment of rheumatism, as it is more pleasant to take, less irritant to the stomach and less depressant to the heart; but it is less powerful than Sodium Salicylate. Aspirin is extensively used in colds, influenza and other fevers, and in neuralgia, headaches, tabes and other pains, in tablets or capsules.

BENZOIN

Benzoinum.—Benzoin. *Synonym.*—Gum Benzamin. A balsamic resin obtained from the incised stem of *Styrax benzoin.* It occurs in greyish-brown lumps, white inside, having an agreeable balsamic odour, and aromatic acrid taste. It is soluble in 5 parts of alcohol (90 per cent.);

and easily soluble in ether and potash. It contains 12 to 20 per cent. of *benzoic acid*, traces of *cinnamic acid*, *resin* and a *volatile oil*.

Dose—10 to 30 grs.—0·6 to 2 G.

1. **Adeps Benzoatus.**—3 per cent. in prepared lard.

2. **Tinctura Benzoini Composita.** *Synonym.*—Friar's Balsam. It contains 10 per cent. of benzoin with storax, balsam tolu and aloes in alcohol.

Dose—30 to 60 ms.—2 to 4 mils.

ACTION AND THERAPEUTIC USES

Benzoin is an **expectorant** like balsam tolu. It is, however, seldom used internally. But it may be inhaled with great benefit in acute or chronic bronchitis and in catarrhal or spasmodic laryngitis. A tea-spoonful of the compound tincture is dropped on the surface of boiling water in a narrow-mouthed vessel and the vapour is inhaled through a cone, made of paper ; traces of the oil and benzoic acid are deposited on the mucous membranes to act as **antiseptic** and **stimulant.** The tincture is also used externally as a stimulating and antiseptic application to foul smelling and unhealthy wounds. Diluted with equal parts of glycerine, it has been recommended as an application to anal fissure and for chapped hand and lips. It is added to lard and suet to prevent rancidity, when used as ointment basis.

Acidum Benzoicum.—Benzoic Acid. *Synonym.*—Flowers of Benzoin. It is obtained by sublimation from gum benzoin ; or it is prepared synthetically from toluene, hippuric acid and other organic compounds. It occurs in lustrous scales, or light feathery friable needles, having an agreeable aromatic odour when obtained by sublimation, and without any odour when prepared synthetically. It is insoluble in water ; soluble in 12 parts of boiling water, and readily soluble in fixed and volatile oils and solutions of alkalies.

Dose—5 to 15 grs.—0·3 to 1 G.

Tinctura Opii Camphorata.—Contains 0·5 per cent. of Benzoic Acid. (See page 223.)

Sodii Benzoas.—Sodium Benzoate. Occurs as a crystalline or amorphous powder, having a faint odour of benzoin, and a sweetish alkaline taste. It is easily soluble in water.

Dose—5 to 30 grs.—0·3 to 2 G.

ACTION OF BENZOIC ACID AND SODIUM BENZOATE

External.—Benzoic acid has no action on the intact skin but on raw surfaces and mucous membranes, it acts as an irritant. Like salicylic acid, it has antifermentative and antiputrefactive properties, and is used as a preservative for originally sterile, acid food products, such as preserves, jellies, etc.

Internal.—*Alimentary Tract.*—In the stomach, benzoic acid may act as a mild irritant but benzoates are practically devoid of such an action. In the intestines, benzoates are used as antiseptics and are credited with the power of increasing the secretion of bile.

Absorption and Elimination.—It is rapidly absorbed into the system from the gastro-intestinal tract and circulates in the blood as sodium benzoate. In the tissues, benzoic acid is liberated and the major portion of it, while passing through the body takes up glycocoll, and appears in the urine as hippuric acid, the synthesis taking place in the kidneys. This is proved by the fact that when the benzoic acid is prevented from reaching the kidneys, by ligature of the renal vessels or by the tissue of the kidney being damaged, no hippuric acid appears in the urine. Hippuric acid, in its passage through the kidneys, stimulates the renal cells to act as a **diuretic,** and at the same time renders the alkaline urine acid. The remainder of the acid is excreted through the lungs, salivary glands and skin, stimulating their secretion and acting as **expectorant, sialagogue** and **diaphoretic.**

Metabolism.—Benzoic acid, like salicylic acid, increases nitrogenous metabolism ; but unlike it, it lessens the excretion of uric acid.

Temperature.—Benzoic acid and its salts lower the febrile temperature, and act as **antipyretics.** In this respect, they are said to be more powerful than salicylates, and are recommended as substitutes for them in rheumatic fever, as they produce no nervous disturbances.

THERAPEUTIC USES

Since benzoic acid acidulates and disinfects the urine, it is given in inflammation of the bladder and other genito-urinary diseases. In the form of Tincture Opii Camphorata, or Tincture Opii Ammoniata, it is used as an expectorant. It is used sometimes as an antiseptic lotion. Sodium benzoate is less irritating and less antiseptic than benzoic acid, and is used for the same purpose as benzoic acid. It is also used as an antipyretic and hepatic stimulant. Ammonium Benzoate is given in chronic bronchitis, and in gout and allied conditions.

GROUP XIV

DRUGS HAVING ANTIPYRETIC AND ANALGESIC PROPERTIES

Amidopyrine, Phenazone, Phenacetine

General Remarks.—By the fractional distillation of coal tar are obtained a number of bodies having aromatic odour which are largely used as antipyretics or antiseptics. They are benzol derivatives and contain one or more hexagonal benzol rings into their structural formulæ. The benzol itself has a low toxicity as it cannot react with protoplasm ; but it could be made to act in a different manner and in a different degree by the introduction of different radicals into its structure at different places. The introduction of an atom of nitrogen, either in the ring or attached to it, produces substances which exert narcotic action on the central nervous system, and their depressing effect is more marked on the heat-regulating mechanism in the brain, while the introduction of alkyl radical increases its bactericidal effect with coincident lessening of toxicity to the higher animals.

An alteration in the physiological action of the carbon compounds of the aromatic series can be effected by slight changes in their chemical structure. General attempts are, therefore, being made to produce substances which should possess strong antipyretic effect without its side actions. In fact all attempts have been directed to produce an ideal antipyretic which ought to possess the following properties :—

1. It must be reliable in securing a fall of febrile temperature.
2. It must be prompt but not too abrupt.
3. It must be lasting and when the effect passes off, the temperature must not rise too suddenly.
4. Its analgesic action must be strong.
5. It must not be decomposed in the stomach.
6. Its toxic dose should be considerably higher than the therapeutic dose.
7. In therapeutic doses it must not cause profuse sweating, nor depress the heart, nor form methæmoglobin or skin eruptions, and above all,
8. It must be soluble in water.

Of the official antipyretics, the only drug which very nearly fulfils these demands is *phenacetin*.

AMIDOPYRINE

Amidopyrina. *Synonym.*—Pyramidon, Diethylamino-antipyrine. It occurs as colourless crystals or crystalline powder almost tasteless and odourless. Soluble in 18 parts of water and 2 parts of alcohol.

Dose—2 to 5 grs.—0·12 to 0·3 G.

PHENAZONE

Phenazonum. *Synonym.*—Antipyrin. Occurs as colourless, tabular crystals with a slightly bitter taste. Freely soluble in water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

PHENACETIN

Phenacetinum. *Synonym.*—Acetphenetidin. Occurs as colourless, tasteless, scaly crystals, almost insoluble in water.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION OF COAL-TAR ANTIPYRETICS

External.—The synthetic antipyretics, especially antipyrin are slightly **astringent, antiseptic, analgesic** and **hæmostatic** in about 5 per cent. solution.

Internal.—None of these in therapeutic doses exerts any action on the gastro-intestinal tract.

Absorption and Elimination.—They are all rapidly absorbed and rapidly excreted. All antipyretics with the exception of antipyrin are mainly oxidised in the body to para-amido-phenol and the intensity of their action depends on the rapidity with which they are so converted. When the decomposition is quick, it is followed by destructive blood changes and a tendency to collapse while the antipyretic effect passes off soon. They are excreted in the urine as compounds of sulphuric and glycuronic acids. The traces are also found in the sweat and sputum.

Blood.—In therapeutic doses, these drugs do not materially affect the blood; but given in larger doses or if their use is continued long, they convert the **oxyhæmoglobin of the red blood corpuscles into methæmoglobin.**

Circulatory System.—In medicinal doses, these stimulate the heart and the vaso-motor centre producing rise of the blood pressure. The rapidity of the heart is due to the depression of the vagus centre. Large doses depress the heart by their direct action on the heart muscles. The heart beat is slow, weak and irregular. The blood vessels dilate and the blood pressure falls. These effects are more marked with pyramidon and antipyrin and least with phenacetin.

Respiratory System.—Respiration is not affected by ordinary doses. In toxic doses the respiratory centre is depressed, which reduces the rate and depth of respiratory movement, causing dyspnœa and cyanosis.

Temperature.—The mechanism, by which these drugs lower the temperature, appears to be the same with all of them, and the fall is not due to their effect on circulation, nor is it due to their slight diaphoretic action; for it continues to fall even when perspiration is checked by atropine. They have a central action and they reduce the febrile temperature by alterations effected in the heat regulating centre, the nervous mechanism of which is supposed to be in the region of the corpus striatum at the base of the brain. In health, the heat regulating mechanism is set for a certain temperature but in fever this setting is on a higher level. These antipyretics, by their action on the heat regulating mechanism, lower the point at which a high temperature is maintained; and as a consequence of this, there is a decrease of heat production and an increase of dissipation to free the body of accumulated warmth. The increased output is maintained by the radiation of heat, through the dilated cutaneous vessels and perspiration. These antipyretics, therefore, also lower the temperature by increasing the heat loss and when the heat regulating mechanism is depressed too rapidly by them, a condition of collapse is produced.

Nervous System.—In moderate doses, these antipyretics are nervine **sedatives** and **analgesics.** They produce a slight tendency to sleep and diminish the sensibility to pain by depressing the thalamic cell station of the pain fibres and not by depressing the cerebral cortex. The cortical cells are partly depressed, but even in large doses the intellectual functions are not interfered with as by morphine, chloral and other cerebral depressants. In toxic doses, they produce convulsive effect as by strychnine. This is probably due to the stimulation of the spinal centre or to asphyxia.

Kidneys.—Apart from the appearance of decomposition products of para-amido-phenol and blood pigment in the urine, there is no effect on the kidney function. If the blood destruction is extreme, its debris irritate the kidneys and cause albuminuria.

Skin.—These exert a **diaphoretic** action on the skin and even in therapeutic doses, sometimes, cause erythematous or urticarial eruptions.

Idiosyncrasy.—Even in therapeutic doses these drugs produce alarming symptoms and they are due to the idiosyncrasy on the part of the patient to these drugs. There may be symptoms (1) of gastro-intestinal irritation, resulting in vomiting and purging; (2) of collapse, manifested in shallow respiration, thin irregular almost imperceptible pulse, drowsiness, cyanosis due to weakened heart and also to the formation of methæmoglobin; (3) of skin manifestations, resulting in erythematous or scarlatiniform or urticarial rash probably due to disturbance in the peripheral circulation.

The action of Antipyrin.—The most soluble of the three, varies with its dose. It is not oxidised in the body and unless taken in a large quantity, it does not depress the heart. Its vaso-dilatation action being powerful, it causes rapid fall in temperature. It has a greater tendency to cause sweating and skin eruptions than has Amidopyrine, and a lesser tendency to cause cyanosis. It is doubtful whether it has a tendency to cause methæmoglobin. Its analgesic action is lesser than that of Amidopyrine, but its property of relieving spasms of plain muscles is greater and it proves a useful drug for this purpose.

Amidopyrine is one of the new compounds introduced as a substitute to antipyrin and without its poisonous properties. Its effects on the nervous system are more powerful and lasting than of antipyrin. It can be given in smaller doses, thereby rendering action slower. It is harmless to the blood, kidneys and the heart.

Phenacetin, of the three drugs, is the safest of the antipyretics. It is almost identical in action with Amidopyrine, but its tendency to the depression of the heart and cyanosis is less, owing to its slow conversion into para-amido-phenol. Its disadvantages are that the tolerance to the drug is established requiring larger doses to effect a cure and the habit is readily induced, which ultimately weakens the heart and proves disastrous.

THERAPEUTIC USES

Externally, all antipyretics are antiseptics, analgesics and hæmostatics. Internally they are given to reduce temperature in fever and to induce comfort by lessening pain and headache. They are largely used as analgesics in headache and migraine to relieve the pain of neuralgia, dysmenorrhœa, ataxia, etc., and to allay nervous excitability in epilepsy, chorea, hysteria, whooping cough, etc. Antipyrin was once used for the cure of diabetes, but its use is of doubtful value.

Caution.—These drugs are only to be used in emergencies when naught else will serve the purpose, and the patient must be warned against repeated use of the same.

GROUP XV

DRUGS OTHER THAN VOLATILE OILS, HAVING CHIEFLY A DIURETIC ACTION, AND URINARY ANTISEPTICS

Theobromine, Theophylline, Urea, Hexmine, Mandelic Acid.

DIURETICS

Theobromine and Theophylline are purin or xanthin derivatives, like caffeine, and are found in the leaves of *Cocao* and *Thea sinensis* respectively. They are isomers and in their basic form they are soluble with difficulty in water; hence they are therefore rarely used in medicine. They however form soluble salts with alkaline metals and their sodium salts are used therapeutically for their diuretic action. They can be prepared synthetically.

Theobromina et Sodii Salicylas.—Theobromine and Sodium Salicylas. *Synonym.*—Diuretin. It is obtained by the interaction of sodium hydroxide, theobromine and sodium salicylate. It contains not less than 46 per cent. of theobromine. It occurs as a white amorphous powder: odourless; sweetish in taste; and soluble in 1 part of water.

Dose—10 to 20 grs.—0·6 to 1·2 G.

Theophyllina.—Theophylline. *Synonym.*—1 : 3 dimethyl xanthine. A white, odourless, crystalline powder with a bitter taste. Soluble in 120 parts of water at 25° C; more soluble in hot water; soluble in 80 parts of alcohol (95 per cent.) It is chiefly used in the preparation of injection of mersalyl to inhibit the decomposition of mercurial complex.

Theophyllina et Sodii Acetas.—Theophylline and sodium Acetate. It is obtained by the interaction of sodium theophylline and sodium acetate. It contains not less than 55 per cent. of anhydrous theophylline. It occurs as a white crystalline powder, odourless, and bitter in taste.

Dose—2 to 5 grs.—0·12 to 0·3 G.

ACTION AND THERAPEUTIC USES

Theobromine and Theophylline have a specific action on the kidneys and act like caffeine. Like caffeine they both act as diuretics by improving the renal circulation, by increasing the glomerular filtration and by preventing the reabsorption of water by the tubules. They, however, differ from caffeine by being more certain and prompt in their effect and having no stimulant effect on the central nervous system.

In its diuretic action theophylline is more prompt than caffeine or theobromine ; but its effects are less lasting. This advantage is, however, set at naught by the fact that in certain individuals it produces renal irritation and epileptiform convulsions. It is said to dilate the coronary artery even in small doses, in contrast to caffeine.

Therapeutically, these salts are largely used in the treatment of œdema and accumulation of fluid in the chest or abdominal cavity, whether of cardiac, renal or hepatic origin. It acts best in cardiac dropsy and chronic Bright's disease. In moderately large doses, they are of value to lower the blood pressure in angina pectoris, arteriosclerosis and aneurysm.

UREA

Urea. *Synonym.*—Carbamide. It is the diamide of carbonic acid and occurs as colourless, transparent crystals, with a cool saline taste and without odour. Easily soluble in water, hot or cold ; soluble in 5 parts of alcohol (90 per cent.).

Dose—15 to 240 grs.—1 to 16 G.

ACTION AND THERAPEUTIC USES

Urea in a saturated solution acts as a non-toxic **antiseptic** dressing for wounds. It is given internally as an efficient and prompt **diuretic** acting probably by raising the *osmotic tension of the urine and thus preventing the normal* reabsorption of water by the tubules.

URINARY ANTISEPTICS

HEXAMINE

Hexamina.—Hexamine. *Synonyms.*—Methenamina ; Urotropine; Cystamine; Cystogen ; Formin ; Hexa-methylene-tetramine. Occurs in colourless crystals, or crystalline powder, with a sweetish, afterwards bitter, taste ; it is soluble in water. It burns with a smokeless flame.

Incompatibles.—Tannin, oxidising agents and mercuric chloride. Alkalies and alkaline salts prevent its conversion into formaldehyde.

Dose—10 to 30 grs.—0·6 to 2 G.

ACTION AND THERAPEUTIC USES

Hexamine which is used mainly as a **urinary antiseptic** is itself devoid of any antiseptic, irritant or toxic properties. Its antiseptic value depends upon the liberation of formaldehyde from its composition and it is favoured by a free acid and arrested by an alkali. It is absorbed unchanged in the blood and passes into all the body fluids and excreta. These being, in general, alkaline or neutral in reaction, it exerts no action there but in the urine, owing to its acidity, it is slowly broken up and formaldehyde is liberated. In neutral or alkaline urine its efficacy is practically nothing. Such urine, however, may be made acid, for Hexamine to act as urinary antiseptic, by the administration of such drugs as acid sodium phosphate and benzoates which acidify the urine and these must be given an hour before or after the administration of Hexamine. Their simultaneous administration should be avoided as they would set free formaldehyde prematurely, and this, to a certain extent, occurs when the drug is given by the mouth. Apart from the urine, the only other place where it exerts its antiseptic action is in the gall bladder and billiary passages. This is probably due to the presence of free bile acids. It is also said to enter into combination with uric acid to increase its solubility and hence its elimination. It is largely used in typhoid fever to lessen the chances of cystitis and also to prevent the spread of infection. It is used in the infection of urinary tract other than of typhoid origin such as pyelitis, cystitis and urethritis. It is, therefore, of value in the early stages of gonorrhœa in the male. It is used as a solvent of uric acid in uric acid diathesis.

MANDELIC ACID

Acidum Mandelicum. *Synonym.*—Phenyglycollic Acid. It occurs in white crystals with an acid taste. It is soluble in water and alcohol.

Dose—30 to 60 grs.—2 to 4 G.

ACTION AND THERAPEUTIC USES

The ketogenic, or a high fatty diet, is responsible for introducing mandelic acid into the pharmacopœia. The ketogenic diet causes highly acid urine to be secreted. **The acidity of urine possesses an antiseptic value. The mandelic acid,** the least toxic of the hydroxy acids, **raises the urinary acidity to the requisite level** (pH. 5·5) in which the bacteria do not grow.

Mandelic acid has been recommended in acute and chronic pyelitis, cystitis and bacilluria, and it is used also in the pyelitis of pregnancy. It is most effective against infections by B. Coli and strep-fœcalis. Mandelic acid is contraindicated in renal diseases, with high blood urea, and in acute febrile cases until the pyrexia has settled.

GROUP XVI

DRUGS ACTING LOCALLY ON THE UTERUS

ERGOT

Ergota.—Ergot. The dried scleroticum of *Claviceps purpurea*, a fungus, originating in the ovary of Secale cereale—the common rye. It is about ½ inch to 1 inch long and about ⅛ of an inch in thickness, generally curved longitudinally, furrowed on both sides, purplish black without and pinkish white within. It is a very unstable drug which loses its activity after being kept for a few months. Ergotism is said to occur during the first four months after harvest. The composition of ergot is very complex, but its chief constituents are:—*Ergotoxine*, an amorphous alkaloid, *Ergotamine* and other alkaloids having action identical with ergotoxine. *Tyramine*, a body formed from amino acids during the putrefaction of animal matter by elimination of carbon-dioxide. It is closely related both chemically and pharmacologically to adrenaline. *Histamine*, or Ergamine, is formed from histidine through the agency of putrefactive organisms. It contains 30 per cent. of fixed oil.

1. **Ergota Præparata.**—Prepared Ergot is ergot which has been powdered and immediately deprived of its fat to prevent the decomposition of its alkaloidal contents. It contains 0·1 per cent. of the total alkaloids of ergot calculated as ergotoxine

Dose—5 to 15 grs.—0·3 to 1 G.

2. **Extractum Ergotæ Liquidum.**—An aqueous solution preserved with alcohol (90 per cent.). When freshly prepared it contains 0·06 per cent. of the total alkaloids of ergot calculated as ergotoxine. 20 minims contain about 1/30 grain of the total alkaloids.

Dose—10 to 20 ms.—0·6 to 2 mils.

Ergometrina.—Ergometrine, *Synonym.*—Ergonovine, Ergotocin, Ergobasine. It is an alkaloid obtained from ergot and purified by crystallisation from a suitable solvent. It occurs in colourless, hygroscopic crystals becoming coloured on exposure to air. It is moderately soluble in water, in alcohol and in acetone; sparingly soluble chloroform and benzene.

Dose—$\frac{1}{120}$ **to** $\frac{1}{60}$ **gr.—0·0005 to 0·001 G.** orally.

$\frac{1}{240}$ **to** $\frac{1}{120}$ **gr.—0·00025 to 0·0005 G.** by intramuscular injection·

$\frac{1}{480}$ **to** $\frac{1}{240}$ **gr.—0·000125 to 0·00025 G.** by intravenous injection.

Ergotoxinæ Æthanosulphonas.—Ergotoxine Ethano-Sulphonate is the ethane sulphonate of an alkaloid ergotoxine obtained from ergot. It occurs as colourless, odourless, acicular crystals, sparingly soluble in water, more in alcohol. It contains approximately 83·6 per cent. of ergotoxine. It is always administered by subcutaneous or intramuscular injection.

Dose—$\frac{1}{120}$ **to** $\frac{1}{60}$ **gr.—0·0005 to 0·001 G.**

ACTION OF CRUDE ERGOT

The physiological action of crude ergot, in which form it is used in medicine, is a combination of action of its various constituents possessing different yet independent actions of their own. The resultant effects of their action is manifested in the stimulation of the muscles of the uterus, blood-vessels and of the bowels. To understand these effects the precise knowledge of these constituents is necessary though they are not as a rule prescribed separately in medicine.

Ergometrine.—It is a crystalline alkaloid isolated from the aqueous extract of Ergot and held to be responsible for the traditional clinical effect of Ergot. The removal of Ergotoxine from the former does not impair its activity. Nothing definite is as yet known about its mode of action.

Though comparison of the actions of alkaloids Ergometrine and Ergotoxine show that the latter is slower in its action even by intravenous injection and is required to be given in larger doses to produce the same effect which are produced by very small doses of Ergometrine orally. Ergometrine is less poisonous and appears to be free from undesirable side effects—nausea, headache and gangrene—which are seen after administration of even therapeutic doses of Ergotoxine. It is more consistent and safer in its action on uterus than the pituitary extract which is rapid, intense and erratic in its action. It occasionally causes pituitary shock and in certain circumstances it lessens the cardiac output. It is, therefore, dangerous to use in patients who are already shocked.

Ergotoxine and Ergotamine.—These alkaloids are identical in their actions. They stimulate, and later on depress the myoneural junctions of the excitor (constrictor) fibres of the sympathetic leaving the inhibitory (dilator) fibres untouched. But adrenaline acts to stimulate both fibres of the sympathetic. This is proved by the fact that if adrenaline, which is primarily concerned in the raising of blood pressure, be injected after paralysing effect of Ergotoxine on the constrictor fibres, the constrictor action of the adrenaline is nullified and the dilator-effect becomes more prominent to cause a fall in blood pressure and thus produces the so called " vasomotor reversal of Dale." Therapeutically they cause contraction of the uterus, of the arteries and subsequent gangrene, bronchial spasms and augmentation of intestinal peristalsis. Though both Ergometrine and Ergotoxine contract the uterus, their mode of action and the associated phenomena differ in many points which are tabulated below :

	ERGOMETRINE.	ERGOTOXINE.
1.	Soluble in water ;	Sparingly soluble in water.
2.	Action is prompt ;	Action is delayed.
3.	Action is less prolonged ; lasts for 2 or 3 hours ;	Action is prolonged ; lasts for about 6 hours.

	ERGOMETRINE.	ERGOTOXINE.
4.	It stimulates sympathetic myoneural junctions;	With moderate dose, it paralyses myoneural junctions.
5.	Not a medullary stimulant;	Medullary stimulant.
6.	Constricts blood vessels;	Constricting of blood vessels is prolonged. Therefore it causes gangrene.

External.—None.

Internal.—*Alimentary Tract.*—In small doses, ergot does not produce any appreciable effect on the stomach and intestines. In moderately large doses, it increases the tonus and peristalsis of the whole of the gastro-intestinal tract, probably the effect of the histamine in the crude drug on its muscular fibres. Since the sympathetic nerve endings are inhibitory to the intestinal tract, the stimulation of them by ergotoxine or tyramine rather inhibits the peristaltic movement; but they constrict the blood vessels of the intestines partly by the direct action on the walls of the vessels and partly by the contraction of the muscular fibres of the intestines. The result is seen in the blanching of the intestines.

Absorption and Elimination.—The active constituents of ergot are absorbed slowly from the intestinal tract and produce a prolonged effect. They are mainly oxidised in the body as none of them appears in active form in any of the excreta.

Circulatory System.—The most striking effect of ergot is the **rise of blood pressure.** It is due to the contraction of all the blood vessels of the body, particularly of the splanchnic area, induced by the stimulation of the sympathetic endings in their walls by ergotoxine and tyramine. In consequence of this rise of blood pressure the vagal centre in the medulla is stimulated to slow the heart, and at the same time the histamine of the crude drug acting directly on the muscle of the heart stimulates it to increase the force of its contraction.

The net results of these is to increase the cardiac output. With the rise of the pressure in the systemic blood vessels, the pulmonary pressure also rises on account of the increased output from the right side of the heart. In consequence, the pulmonary capillaries dilate as they have no muscle in their walls to contract under the influence of ergotoxine and tyramine. The administration of ergot to check pulmonary hæmorrhage, therefore, proves harmful. In large doses, ergot paralyses the terminations of the sympathetic nerves in the arteries as well as the vaso-motor centre in the medulla, and it depresses the heart. The blood pressure, therefore, falls. Vascular constriction may affect the secretion of saliva, sweat and milk.

Respiratory System.—Respiration is not much affected by therapeutic doses; but large doses slow the breathing.

Uterus.—Ergot in small doses raises the tone of the uterine muscle by the direct action of the histamine in it; and in moderately large doses it excites rhythmic contraction by the stimulation of the sympathetic endings in it by ergotoxine and tyramine. This, in the normal uterus, augments the menstrual flow, and thus it acts as an **emmenagogue.** In the pregnant uterus, the contractions increase in force and frequency, particularly at the approach of parturition, and expel the contents of the uterus. It thus acts as an **ecbolic.** In large doses, the action of histamine comes into play more prominently; the contractions become tonic and violent and, if there be any obstruction for the fœtus to come out, it may cause rupture of the uterus.

Ergotism.—Continued administration of ergot as medicine or the ingestion of bread made out of the infected grain of rye, produces a train of symptoms of chronic poisoning, which is called ergotism. There are two varieties of chronic poisoning—the Spastic or convulsive and the Gangrenous.

Spastic or Convulsive Ergotism.—In this type of poisoning, nervous symptoms predominate and the earliest symptoms manifested are, muscular weakness, general depression, loss of appetite and epigastric distress. There may be some vomiting and diarrhœa. Later on, there are disturbances of sensation which begin at the periphery and then spread all over the body. There is itching and tingling of the limbs which are followed by formication—the sensation of an insect creeping over the skin. This is followed by motor effects, which are manifested by tonic contractions of various muscles, especially those of the extremities, causing tremors and painful spasms. The gait becomes staggering. There may be epileptiform convulsions. And death occurs from asphyxia due to spasm and weakness of respiratory muscles. These effects are due to progressive degenerative changes in the brain and spinal cord.

Gangrenous Ergotism.—This is a much more common variety of ergotism in which circulatory symptoms are prevalent. It rarely occurs in an epidemic form and is generally the result of continued and indiscriminate administration of ergot as medicine. Continued administration of ergot thickens the arterial walls and diminishes their lumen, causing less blood to reach the peripheral parts. In consequence, there is a burning and tingling sensation in the tips of the fingers and toes and other peripheral parts. They become icy cold, lose their sensation and assume a dark, shrunken appearance, and ultimately they fall off. Gangrene of the skin is manifested by pustular eruptions.

THERAPEUTIC USES

Ergot and its preparations are chiefly used in medicine to cause contraction of the uterus after labour and in excessive menstruation. It should be cautiously used during the progress of labour, as it produces prolonged uterine contractions which may prove dangerous to the life of the child, and if the resistance be great, it may even cause rupture of the uterus. It is also used to raise the blood pressure in failing circulation and to check also hæmorrhages other than that from the uterus. It is given to check night-sweats of phthisis.

Histaminæ Phosphas Acidus.—Histamine Acid Phosphate. *Synonym.*—Histamine Phosphas. It is the di-acid phosphate of an organic base. It may be prepared by the action of phosphoric acid on histamine which may be obtained from natural sources or by synthesis. It occurs in colourless, odourless crystals soluble in water, slightly soluble in alcohol.

Dose— $\frac{1}{120}$ **to** $\frac{1}{60}$ **gr.—0·0005 to 0·001 G.**

ACTION AND THERAPEUTIC USES OF HISTAMINE

Histamine is not absorbed from the alimentary tract and is, therefore, given by subcutaneous injection for therapeutic effects. If histamine is injected into the skin it produced a typical "**triple response.**" (1) Local dilation of the capillaries and venules by direct action ; (2) widespread dilation of surrounding arterioles from local axon reflex ; (3) local increased permeability of the walls of the minute vessels, increased exudation of fluid and wheal formation. Injection is usually followed by flushing of the skin, vertigo, headache and tachycardia. After absorption, **it stimulates the smooth muscles, especially those of the bronchi and uterus. The blood pressure falls** accompanied by symptoms as in surgical shock and **is due to direct dilation of the capillaries,** associated with arteriolar contraction.

It stimulates secretion of hydrochloric acid from gastric glands without influencing the digestive enzymes. It is used for testing of secretory activity of acid in the stomach. It has been found effective in the treatment of chronic rheumatism and allied disturbances.

GROUP XVII

ANTISEPTICS AND ANTIPARASITICS

Antiseptics.—Acid Boric, Hydrogen Peroxide, Sulphanilamide, Phenol, Cresol, Creosote, Guiaiacol, Trinitrophenol, Acriflavine, Proflavine Sulphate, Chiniofon, Resorcinol, Betanaphthol, Formaldehyde, Ichthammol.

Antiparasitics.—Sodium Metabisulphite, Chrysarobin, Hydnocarpus Oil, Balsalm Peru, Benzyl-benzoas, Sulphur.

ANTISEPTICS

ACIDUM BORICUM

1. Acidum Boricum.—Boric Acid. *Synonyms.*—Boracic acid, Hydrogen Borate, occurs in white glistening scales that feel greasy to the touch, soluble in 25 parts of cold water, freely soluble in boiling water and in glycerine.

Incompatibles —Sodium Salicylate in powder; a borosalicylate is formed.

Dose—5 to 15 grs.—0·3 to 1 G.

1. **Glycerinum Acidi Borici.**—Contains 30 per cent. of hydrogen borate.
2. **Unguentum Acidi Borici.** —Contains 10 per cent. of hydrogen borate.

2. Borax.—Borax purificatus. *Synonym.*—Sodium Biborate. Transparent colourless crystals, soluble in 25 parts of cold water; readily soluble in hot water and glycerine.

Dose—5 to 15 grs.—0·2 to 1 G.

1. **Glycerinum Boracis.**—Contains 12 per cent. of borax.
2. **Mel Boracis.**—Contains 10 per cent. of borax.

ACTION OF BORIC ACID AND BORAX

External.—The **antiseptic** effect of boric acid and borax is very nearly equal and is not dependent on acidity or alkalinity. They prevent the growth of bacteria in dilute solution; but even in saturated solution, they do not kill them. On raw surfaces, they are somewhat **astringent**, and they do not exert any irritant action even in saturated solutions.

Internal.—*Alimentary Tract.*—Solutions of boric acid or borax in water or glycerine when used as mouth-washes, exert their **antiseptic** action in sore throat, in aphthous stomatitis and in thrush. In the stomach and intestines, they act as mild gastro-intestinal **irritants.** They exert very little antiseptic action there.

Kidneys.—Boric acid is rapidly eliminated in the urine. It is partly excreted in saliva, sweat, and fæces. During excretion, boric acid increases the acidity of urine; while borax increases the alkalinity of urine, but it never loses its antiseptic value even in alkaline urine. They both, therefore, act as **genito urinary Antiseptics.**

Uterus.—When given in small doses, it acts as an **emmenagogue.** In larger doses, it produces uterine contractions and acts as an ecbolic.

Nervous System.—Borax is believed to act as a **sedative** to the nervous system and is generally given as a synergist to Bromides.

Toxic action.—Chronic poisoning from Borax or Boric acid is generally observed by the continued use of food preserved with them. The first symptom is that of loss of appetite followed by signs of gastro-intestinal irritation, nausea, vomiting and mild diarrhœa. There is nervous prostration and muscular weakness. In some, cutaneous lesions in the form of scaly dermatitis, dryness of skin and loss of hair have been observed.

THERAPEUTIC USES

Boracic Acid, dissolved in water or as an ointment, is a much used remedy for wounds in which there is little or no sepsis. As it causes very little irritation, it is used largely as an eye-wash, mouth-wash, and for washing out the stomach in fermentation; it is also used as a bladder-wash in cystitis. This dissolves the phosphatic debris deposited on the mucosa. It is also used as a vaginal douche in leucorrhœa. It is used in alcoholic solution, 10 grs. to 1 oz. of alcohol to act as an antiseptic and to check the flow of discharge from the ear. Internally, it is given as a remedy for scanty menstruation and for epilepsy. It has been suggested as a remedy for obesity. Borax with glycerine is used as the principal remedy for aphthous stomatitis and thrush.

HYDROGEN PEROXIDE

Liquor Hydrogenii Peroxidi.—A colourless liquid with a slightly acid taste, which renders the saliva frothy.

Dose—30 to 120 ms.—2 to 8 mils.

ACTION AND THERAPEUTIC USES

It is a powerful oxidising agent as it easily liberates oxygen in contact with living tissues and various oxidising and reducing substances. It is chiefly used as an **antiseptic** and a cleansing agent in open wounds and on inflamed mucous surfaces. In concentrated solution, it coagulates albumen and acts as a **hæmostatic.** Its disadvantage is its instability. It bleaches colouring matter and hair. At one time it was given internally as an intestinal disinfectant in typhoid fever and as a curative in diabetes, uræmia and epilepsy.

Caution.—It is dangerous if given subcutaneously or used to wash out serous cavities. There is immediate decomposition with the release of oxygen and gas emboli are produced, which, getting entrance into the blood, lodge in the lungs and brain and cause death.

SULPHANILAMIDE

Sulphanilamidum. *Synonym.*—p-aminobenze-sulphonamide, prontosilalbum. It occurs in a white crystalline powder and is odourless and almost tasteless, sparingly soluble in water.

Dose—8 to 15 grs.—0·5 to 1 G.

ACTION AND THERAPEUTIC USES

The sulphanilamide, when orally given, is readily absorbed from the alimentary tract, and effectively penetrates into all tissues as well as the cerebro-spinal fluid, and is excreted by the kidneys. With suitable concentrations of the drug in the body, bactericidal action is excreted on invading micro-organism. Although sulphanilamide has a striking therapeutic effect in vivo, its bactericidal effect in vitro is of a small order when compared with some of the modern antiseptics. Sulphanilamide has proved **its bactericidal action in experiments on mice infected with different types of hæmolytic streptococci**; probably it acts by depriving the streptococci of their capsules which protect them against phagocytic or leucocytic attack. Other theories on the mode of action of sulphanilamide have been propounded. An interesting one is that, that sulphanilamide is the precursor of a more active product. p-hydroxl-amino-phenyl-sulphon-amide, which has a strong lethal and inhibitory action on streptococci both in vivo and in vitro. Sulphanilamide is particularly indicated in septic tonsillitis, erysipelas, complications of scarlet fever, puerperal fever, meningococcal or streptococcal meningitis and various other hæmolytic streptococcal infections. The usual daily dose is up to 5 to 8 grammes by mouth, until fever declines and then it is diminished the dose to about two grammes and is continued for a week.

Toxic Actions.—All of us are liable to mild toxic symptoms of sulphanilamide. They are malaise headache, vertigo, nausea and nervous depression. Toxic doses produce severe symptoms of acidosis resembling toxæmia, hæmolytic anæmia, jaundice and of cyanosis—which is due to the formation in the blood of either methæmoglobin or sulphæmoglobin.

These symptoms are aggravated when the intestine contains an excess of sulphur or sulphates and for this reason, during the course of treatment neither food nor any drug is to be given because that increases the sulphur content of the intestine. Hence eggs and sulphate-purgatives should be avoided. Recovery from methæmoglobinæmia is slow. It should be hastened by methylene blue which converts methæmoglobinæmia into hæmoglobin. Methylene blue is given orally or intramuscularly or intravenously.

Sulphonamides.—More potent derivatives of sulphanilamide (*non-official*) under the generic name **Sulphonamide** have been synthesised. Those worth mentioning upon clinical trials are Sulphapyridine (" M. & B. 693," Dagenan) and Sulphathiazole (" M. & B. 760," Thiazamide).

Sulphapyridina.—Sulphapyridine is extensively used in pneumococcal infections with benefit in one gramme doses every 4 or 6 hours. It is supplanted by **Sulphadiazine,** a new hetero-cyclic derivative of sulphanilamide recently prepared. It possesses the following advantages: Low toxicity, rapidly attained high blood concentrations, rapid penetration and slow excretion.

Sulphathiazolum.—Sulphathiazole has proved the most effective in staphylococcal infections. It is also used in gonorrhœa and in general infections of the urinary tract in one gramme doses every 4 hours for four days.

Both Sulphapyridine and Sulphathiazole are being extensively used in cases of bacillary dysentery but they are likely to be supplanted by **Sulphaguanidine,** another derivative of sulphonamide. Sulphonamides are employed locally as antiseptics.

PHENOL

1. Phenol. *Synonyms.*—Acidum Carbolicum. Carbolic Acid. Occurs in colourless or reddish, needle shaped crystals with characteristic tarry odour and pungent sweetish taste. Soluble in 15 parts of water; freely in alcohol, glycerine, fixed and volatile oils. It does not turn blue litmus red. It is called carbolic acid owing to its property of forming salts with strong bases.

Dose—1 to 3 grs.—0·06 to 0·2 G.

It is given in the form of pills made with hard paraffin, wheaten flour and glucanth.

2. **Phenol Liquefactum.**—Liquefied Phenol. *Synonym.*—Acidum Carbolicum Liquefactum. It is an 85 per cent. solution in water.

Dose—1 to 3 ms.—0·06 to 0·2 mil.

1. **Glycerinum Phenolis.**—It is a 16 per cent. solution of phenol in glycerine.
2. **Suppositoria Phenolis.**—Each suppository contains about 1 grain of phenol in oil of theobroma and white beeswax base.
3. **Trochiscus Phenolis.**—Each lozenge contains ½ a grain of phenol in simple basis and coloured with carmine.
4. **Unguentum Phenolis.**—3 per cent. in white paraffin ointment.

ACTION OF PHENOL

External.—Phenol or carbolic acid is a powerful protoplasmic poison. It precipitates proteins forming with them so loose a combination that it readily diffuses further and penetrates more deeply into the tissues than metallic protoplasmic poisons. Applied to the skin, its effects differ according to the concentration. In a weak solution (1 to 4 per cent.) it causes tingling, numbness and local anæsthesia, and if the application be prolonged, the skin becomes shrunken and white owing to the precipitation of proteins, the epidermis is destroyed and later desquamates. In strong solution (5 per cent.) it is an **irritant** and in concentrated solution a **caustic,** causing at first a burning sensation which is quickly followed by **anæsthesia.** At the site of application a white eschar is formed which later separates by sloughing usually leaving a peripheral red zone of inflammation. Sometimes, there is a dry gangrene of the part, particularly of the fingers, when moderately strong solutions are kept in contact with the part for a long time without removal.

The **antiseptic** action of phenol is not hindered by organic matter. It destroys even in dilute solution organised ferments such as yeasts, moulds, etc., and in stronger solutions the unorganised ferments such as pepsin, ptyalin and rennet. The antiseptic value of phenol is increased by the addition of hydrochloric or tartaric acid and also by sodium chloride or other neutral salts. These substances increase the penetration of phenol into the protoplasm. Its solution in oil and strong alcohol abolishes its antiseptic power as it enters into physical combination with these substances from which it is not easily liberated. Phenol is the most widely known and widely used of the antiseptics and owes its popularity to its being the pioneer of the group of all antiseptics. Even now the efficacy of germicides related to phenol is numerically determined in terms of "Phenol Coefficient," which is the amount of phenol required to kill bacteria within a given time, divided by the amount of the other required to effect the same result under identical conditions.

Internal.—*Alimentary Tract.*—Phenol has a sweetish taste and stimulates the secretion of saliva and possibly of the gastric juice. In medicinal doses it neither irritates the gastro-intestinal tract nor interferes with digestion, but acts as a gastric antiseptic, arresting fermentation, and sometimes checking obstinate vomiting. In concentrated solution, it causes the mucous membrane of the mouth and throat to become white, dry and hard, and acts as gastro-intestinal irritant causing abdominal cramp, vomiting and diarrhœa with coincident symptoms of collapse.

Absorption and Elimination.—Phenol is quickly absorbed from the skin, from wounds, from all mucous surfaces and from subcutaneous and celullar tissues. It circulates in the blood unchanged and a large quantity is oxidised in the body into hydro-quinone and pyrocatechin. The unoxidised portion gives rise to phenyl sulphuric and phenyl glycuronic acid, which, with alkaline bases, are converted into phenyl sulphonates and glycuronates, and are excreted as such in urine, with a portion of unchanged carbolic acid. These chemical changes, which lead to the formation of substances of lower toxic value than phenol itself, take place in the liver. It is, therefore, less toxic when absorbed from the stomach than when absorbed by the skin, uterus or bladder. In whatever concentration phenol is administered, it is absorbed upto a certain limit and then its absorption suddenly ceases.

Circulatory System.—Phenol, in medicinal doses, has little action on the heart or blood vessels. In large doses, it depresses the vaso-motor centre and causes the blood pressure to fall. In poisonous doses, it paralyses the heart by its direct action, which becomes weak, and irregular and finally stops in diastole.

Respiratory System.—Is unaffected in small doses. In larger doses, phenol accelerates respiratory phenomena at the same time making shallower. Later on, it slows down probably on account of the stimulation of the respiratory centre. In poisonous doses, the respiratory centre is paralysed, and the respiration becomes laboured, intermittent and noisy and death ensues.

Temperature.—In small doses, it has no effect on temperature; but in moderately large doses, it acts as an **antipyretic** by its direct action on the heat regulating mechanism at the base of the brain.

Nervous System.—In large doses, the systemic actions of phenol are mostly confined to the central nervous system. It depresses the whole of the nervous system with, or without, the stage of initial stimulation. The paralysation of higher centres results in dizziness and coma, which may be preceded by the stimulant effect, as manifested by delirium and convulsions. The anterior cornua of the spinal cord after a brief period of stimulation is also depressed, abolishing reflex action. The vaso-motor and respiratory centres are also depressed and it is the paralysis of the latter that causes death. The peripheral sensory and motor nerves are not affected as phenol never reaches that concentration, after absorption, to produce its poisonous effect on them.

Urine.—The oxidation products of phenol, particularly, pyro-catechin and hydroquinone appearing in the urine, give it a dark green or brownish colour, which becomes darker on standing, owing to further oxidation, and as these products reduce Fehling's solution, their presence may be mistaken for glycosuria.

THERAPEUTIC USES

In its crude form, phenol is used to disinfect and deodorise drains, bed-pans, water closets, etc. It is largely used for disinfecting instruments, utensils, etc. As an antiseptic, it is used in the treatment of wounds, but it must not be applied in large volumes to absorbent surfaces on account of the danger of systemic poisoning. As a sedative it is used in the form of a lotion to relieve itching and irritation, and in the pure form or mixed with camphor to relieve toothache. As a caustic, it is applied to infective ulcers and poisoned wounds. Phenol vapour is inhaled in putrid bronchitis and in phthisis. Internally, it is used as an antiseptic and a sedative in cases of gastric fermentation. In the form of injections, liquid phenol is used to absorb boils and to arrest the spreading of carbuncles and buboes. Its recent use is for the treatment of hæmorrhoids; 20 per cent. phenol solution in glycerine is injected into the pile to produce coagulation and shrinkage. It is also used in 2 or 3 per cent. solution as a subcutaneous injection for the cure of tetanus. Phenol is also useful in various skin diseases, especially those of parasitic causation as psoriasis, scabies, ringworm, sycosis, eczema and such others.

CRESOL

Cresol. *Synonym.*—Cresylic acid. It is a pale-yellow coloured liquid, with a tarry smell; it becomes brown on exposure to light; soluble in 50 parts of water, usually forming a cloudy solution. Freely soluble in alcohol, ether, glycerine, and fixed and volatile oils. It is dissolved by alkali hydroxides.

Dose—1 to 3 ms.—0·6 to 0·2 mil.

Liquor Cresolis Saponatus. *Synonym.*—Lysol. It is a solution of cresol prepared with the aid of linseed oil and potassium hydroxide. It contains 50 per cent. of cresol.

ACTION AND THERAPEUTIC USES

Cresol closely resembles phenol in its action on the bacteria and animals, but it is more powerful and less toxic and caustic. Its disadvantages are its variable composition, disagreeable odour and limited solubility in water. The solubility of cresol, however, could be increased by substances such as sulphuric acid, soap, sodium salicylate and caustics. According to the solvent used, a good many commercial mixtures are brought into use. They are cyllin, lysol, creolin and others.

Chlorocresol. *Synonym.*—Parachlorometacresol. Colourless crystals with characteristic odour. It is slightly soluble in cold water and more soluble in hot water and readily soluble in alcohol, in ether and fixed oil.

THERAPEUTIC USES

The chlorocresols are said to be more strongly germicidal than cresols.

It is chiefly used in surgical and gynæcological practice. Internally it is given diluted with olive oil or in capsules as an intestinal antiseptic. Its vapour is inhaled in putrid bronchitis and in phthisis.

CREOSOTE

Creosotum.—Creosote. It is a colourless or yellowish highly refractive oily liquid with a penetrating smoky odour and a burning taste. Slightly soluble in water, miscible with alcohol, ether, fixed or volatile oils.

Incompatibles.—Explodes when mixed with oxide of silver.

Dose—2 to 10 ms.—0·12 to 0·6 mil.

ACTION AND THERAPEUTIC USES

External.—Topical actions of creosote are similar to those of phenol, but it is seldom used externally. Applied to the skin, it causes the sensation of heat and burning followed by numbness. If the application is prolonged, it acts as an **irritant** and a **caustic.** In diluted solution, it acts as an **astringent** and a **local anæsthetic.** It is used in parasitic diseases of the skin and in the local treatment of various moist and scaly affections of the skin such as eczema and psoriasis.

Internal.—*Alimentary Tract.*—In small doses, well diluted, it **prevents fermentation** and putrefactive changes in the stomach and stimulates **digestion.** In large doses, digestion is impaired, and its continued use may set up gastritis. Creosote in minute doses, like phenol, sometimes checks vomiting, irrespective of its cause, possibly by acting as an anæsthetic. In the intestine, before it is absorbed, it exerts its antiseptic action ; but to reach it in that form, creosote must be administered in specially coated pills which resist the action of the gastric juice.

Absorption and Elimination.—It is rapidly absorbed from the stomach and other mucous surfaces, and from the lungs by inhalation. It circulates in the blood unchanged. A portion of absorbed creosote is oxidised in the body. The remaining portion is excreted by the urine in the form of sulphate of guaiacol and cresol and by the bronchial mucous membrane where it exerts its antiseptic and stimulant action.

Lungs.—It is a valuable **antiseptic expectorant,** especially when there is fetor of the secretion as in putrid bronchitis and gangrene of the lungs, and in the treatment of phthisis. It may be given by the mouth, hypodermically in oil, by rectum or sprinkled on an inhaler. The latter method is, however, preferable when continuous action of the drugs is necessary, as in the treatment of tubercular affections of the lungs.

GUAIACOL

Guaiacol.—Ordinarily it is a colourless or yellowish liquid with a smoky odour and a caustic pungent taste, soluble in 80 parts of water; when chemically pure or prepared synthetically, it occurs in colourless crystals.

Dose—5 to 10 ms.—0·3 to 0·6 mil.

It is best given in capsules diluted in some quantity of almond oil or dissolved in cod-liver oil or sherry.

ACTION AND THERAPEUTIC USES

External.—Guaiacol has the same antiseptic action as phenol and creosote. Guaiacol, when rubbed on the skin, is quickly absorbed and acts as an **antipyretic** and a **diaphoretic,** but the sweating is so profuse that collapse may supervene.

Internal.—When given by the mouth, in repeated doses, it is irritating to the gastro-intestinal tract, causing burning pain, vomiting and diarrhœa. It is employed in pulmonary tuberculosis in place of creosote. Carbonate of Guaiacol, however, should be preferred for internal administration, for it is less likely to disturb digestion as it passes unchanged through the stomach and is decomposed only in the alkaline secretion of the intestines. The freed guaiacol disinfects the small intestine and is therefore largely used as an **intestinal disinfectant** in typhoid fever, intestinal tuberculosis as well as in ordinary phthisis.

TRINITROPHENOL

Trinitrophenol. *Synonym.*—Acidum Picricum. Picric

Acid. A bright yellow crystalline powder soluble in 90 parts of water and in about 10 parts of alcohol (90 per cent.).

Dose—1 to 5 grs.—0·06 to 0·3 G.

ACTION AND THERAPEUTIC USES

Externally it is used as an **antiseptic** especially in cases of burns (1 per cent. solution). There it exerts its **astringent** action by combining with the proteins and forming a yellow precipitate. It stains the skin and fabric yellow. It is too irritant to be used internally.

ACRIFLAVINE

Acriflavina.—Acriflavine. An orange red or brownish red crystalline powder without any odour; taste acid. Soluble in 3 parts of water and in alcohol. It is employed externally only in solution of 1 in 500 to 1 in 5000.

Dose—½ to 1½ grs.—0·03 to 0·1 G.

Proflavinæ Sulphus. *Synonym.*—Proflavine. It is an orange-red crystalline powder. It is soluble in about 300 parts of water.

ACTION AND THERAPEUTIC USES

Recently a series of drugs having similar composition, such as proflavine, trypaflavine, sanoflavine, etc., have been introduced as **antiparasitics** for the treatment of protozoal and trypanasome infection by intravenous injections. The curative value of these drugs in such diseases has proved to be doubtful. They have, however, marked bactericidal power and are extremely useful in the treatment of infected wounds, and acriflavine is largely used for this purpose. Many skin infections such as soft chancres, furunculosis, sycosis, impetigo contagiosa, yield readily to acriflavine applications. It is said to have almost a selective action on the gram-negative bacteria (*i.e.*, bacteria which resist staining by Gram stain) such as gonorrhœa and is therefore largely used in varying strengths for urethral irrigation. Its solution in 1 in 50000 in physiological saline by intravenous injection is said to be useful in cases of septicœmia. Subcutaneous injections give rise to local irritation. After absorption it is excreted unchanged in the urine.

Proflavine is less toxic and acts more slowly. It is a more efficient antiseptic than acriflavine, and in the prevention of gas-gangrene it is said to be even superior to sulphonamides.

RESORCINOL

Resorcinol.—Resorcin. *Synonym.*—Resorcinum. Occurs as colourless or nearly colourless, needle-shaped crystals or powder, with a characteristic odour and sweetish cum bitter taste. It is freely soluble in water, alcohol, glycerine and to a less extent in oils.

Dose—1 to 5 grs.—0·06 to 0·3 G.

ACTION AND THERAPEUTIC USES

Resorcin, externally, is an **antiseptic** and **disinfectant.** It is, however, inferior to phenol in these respects. It is used externally in certain affections of the skin, particularly of the scalp, such as seborrhœa, dandruff and alopecia. Internally, it acts as an **antipyretic;** but is now seldom used, owing to its depressant action on the heart. It has, however, retained its use as a paint in 3 to 5 per cent. solution in various painful conditions of the throat and tonsils.

BETANAPHTHOL

Betanaphthol. *Synonym.*—Naphthol. Occurs in colourless glistening crystals with a phenol-like odour and pungent taste. Almost insoluble in water but easily in alcohol and in fixed oils.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION AND THERAPEUTIC USES

It has the same action as the other members of the phenol group and though its germicidal power is greater, yet it is less toxic and caustic, owing to its being almost insoluble. It is a powerful **antiseptic** destructive to low forms of life. It is used in the treatment of scabies, ringworm and other parasitic diseases of the skin. Internally, it acts as **gastro-intestinal disinfectant,** in fermentative diseases of the stomach, in typhoid fever, chronic dysentery and other bowel diseases. It is also used as an **anthelmintic** for hook-worms. Its action in these cases is purely local. It is absorbed from the mucous surfaces and wounds, but little, if at all, from the unbroken skin. It exerts its special irritant action on the kidneys, when it is absorbed from the wound of the skin. It is, therefore contra-indicated in the presence of renal disease.

FORMALDEHYDE

Liquor Formaldehydi. *Synonym.*—Formalin. An aqueous solution containing 37 per cent. of formaldehyde. It is a clear liquid with a pungent penetrating odour. It is miscible with water and alcohol in all proportions.

ACTION AND THERAPEUTIC USES

Formalin is one of the most **powerful disinfectants.** It is highly penetrating and does not injure the metals, fabric and colour and has relatively low toxicity. It is an **antiseptic** by being a protoplasmic poison, but it is too irritating to be used on the body. In diluted solution, it is repeatedly applied to the skin to check local sweating. It thus acts as an **anhydrotic.** It is also used in 1 per cent. solution as an antiseptic upon accessible mucous membranes, such as of the throat and vagina. It is therefore used as a mouth-wash or gargle, and is given as a douche in inflammatory conditions of the vagina and the uterus. In 3 to 5 per cent. solution it is applied in tonsillitis and diphtheria. The vapour of formalin is irritating to the bronchial and conjunctival mucous membranes. Internally, it acts as a **gastro-intestinal irritant.** After absorption its poisonous effects may be manifested in spinal convulsions, and during excretion by an inflammation of the renal epithelium. The most marked action of formaldehyde on the tissues when used in concentrated solution, or when the contact with them is prolonged, is the hardening effect which it produces on them. It combines with the amido-group in the protein molecule, makes them impermeable and lose their elasticity. It is, therefore, largely used for preservation of museum specimens, for embalming bodies, for dissection and for hardening histological specimens.

ICHTHAMMOL

Ichthammol. *Synonym.*—Ammonium Ichthosulphonate Ichthyol. It is obtained by destructive distillation of fossil schist deposits and treatment with ammonium sulphate and water. It consists of the ammonium salts of the sulphonic acids of an oily substance called ichthyol, together with ammonium sulphate and water. It is a blackish-brown viscid liquid, with a strong characteristic odour ; soluble in water and miscible with glycerine and fixed oils.

Dose—5 to 10 grs.—0·3 to 0·6 G.

ACTION AND THERAPEUTIC USES

Ammonium Ichthosulphonate is a mild **antiseptic** and an **irritant** acting by reducing action. It is used externally in skin diseases especially those of a sluggish or chronic nature such as eczema, psoriasis, favus, acne, etc. It is used chiefly in gynæcological practice. Tampons, or cotton-wool plugs, soaked in 10 to 30 per cent. solution in glycerine, are introduced into the vagina to relieve local swelling and to absorb inflammatory products in cases of pelvic cellulitis. It is absorbed into the system from the skin and digestive tract, and is broken into the body to increase the excretion of sulphur in the urine. It has very little systemic action and is seldom used internally. It is, however, used as an intestinal disinfectant, and as a cure for rheumatism.

ANTIPARASITICS

SODIUM METABISULPHITE

Sodii metabisulphis.—Sodium metabisulphate is a crystalline powder with sulphurous odour. It is soluble in water.

THERAPEUTIC USES

It is a mild antiseptic and is used chiefly as a food preservative.

CHRYSAROBIN

Chrysarobinum.—Chrysarobin. It is a mixture of substances extracted from *Araroba* by hot benzene. It is a brownish to orange yellow crystalline powder, tasteless and inodorous. Sparingly soluble in water and alcohol. It contains more or less chrysaphanic acid, and possibly other decomposition products.

Unguentum Chrysarobini.—4 per cent. in simple ointment.

ACTION AND THERAPEUTIC USES

It is rarely given internally as it is a powerful irritant, but a small amount is taken as a cathartic principle of rhubarb and senna. It is a powerful irritant to the skin giving rise to yellow stains which become violet or purple in the presence of alkalies. It is used as a **parasiticide** in hyphomycetic infestations of the skin such as ringworm and other cutaneous diseases such as psoriasis and acute rosacea.

HYDNOCARPUS OIL

Oleum Hydnocarpi.—A fatty oil expressed from the ripe seeds of *Hydnocarpus Wightiana*. It occurs as an yellowish or brownish yellow oil or soft cream-coloured fat, with a slight characteristic odour and somewhat acrid taste. It is partially soluble in cold alcohol (90 per cent.); and wholly soluble in hot alcohol (90 per cent.). Miscible with ether, chloroform and carbon disulphide.

Dose — 5 to 15 ms. increasing gradually to 60 minims.	**0.3 to 1 mil. increasing gradually to 4 mils.**	By the mouth.
30 ms. increasing gradually to 75 minims.	**2 mils. increasing gradually to 5 mils.**	By subcutaneous and intramuscular injection.

Oleum Hydnocarpi Æthylicum.—Ethyl Esters of Hydnocarpus oil; consists mainly of the ethyl esters of chaulmoogric and hydnocarpic acids, and is produced by esterifying the fatty acids of hydnocarpus oil with ethyl alcohol. It is a colourless, or faintly yellow, limpid oil, with a characteristic odour and a slightly acrid taste.

Dose—Same as that of the Hydnocarpus Oil.

ACTION AND THERAPEUTIC USES

Externally, Hydnocarpus Oil and its fatty constituents are extremely irritating. They are used chiefly in leprosy where they appear to be almost specific. Their administration is said to produce reaction in leprous lesions with their subsequent amelioration in the majority of the patients. It is doubtful whether they produce a real cure.

Balsam Peru (see page 382).

Benzyl-Benzoas (see page 337).

Sulphur (see page 207).

GROUP XVIII.

DIAGNOSTIC DYES

Methylene Blue, Soluble Fluorescein, Indigocarmine.

METHYLENE BLUE

Methylthioninæ Chloridum. *Synonym.*—Methylene Blue. It occurs as a dark green crystalline powder or prismatic crystals having a metallic lustre. It is freely soluble in water and alcohol, the solutions taking a deep blue colour.

Dose—1 to 5 grs.—0·06 to 0·3 G.—Given in capsules.

ACTION AND THERAPEUTIC USES

External.—Methylene Blue, like other aniline dyes, has an antiseptic action ; but it is too feeble in its bactericidal power. It is, therefore, rarely used as an external antiseptic.

Internal.—Methylene Blue administered by the mouth even in moderate doses irritates the stomach and may cause gastric colic and vomiting. It is quickly absorbed into the system and acts as an **internal antiseptic.** It combines with the hæmoglobin of the blood and converts it into methæmoglobin. It is excreted mainly in the fæces and the urine, colouring them blue. During its passage through the bladder, it may exert its irritating action on the bladder and cause painful micturition, but in spite of this action, it is largely used in the inflammation of the genito-urinary tract, and especially in gonorrhœa.

As an internal antiseptic, it shows a decided ability to destroy protozoa and parasitic worms infesting the blood, and is of service in malaria, particularly chronic malaria, which is resistant to the action of quinine. Its electivity in staining the nervous tissue in the body leads to its use in neuralgias and other manifestations of over-active nerves, but its **analgesic** action is not powerful. Methylene Blue, nowadays, is mainly used as a test for renal function ; when 1 c.c. of a five per cent. solution is injected intramuscularly, the urine acquires a green colour in about 20 minutes and the colour deepens in about 4 hours.

FLUORESCEIN SOLUBLE

Fluoresceinum Solubile.—An orange red powder which is almost odourless and tasteless. Soluble in 1 part of water and in 5 parts of alcohol (90 per cent.).

ACTION AND THERAPEUTIC USES

It is used only as a diagnostic agent in affections of the cornea. A 2 per cent. solution dropped in the eye does not stain the normal tissue, but produces yellow colouration on any abraded part or ulceration on the cornea.

INDIGOCARMINE

Indicarminum. *Synonym.*—Sodium Indigotindisulphonate. A blue powder or granules with coppery lustre. Soluble in 100 parts of cold water; readily soluble in warm water.

Dose—¾ to 1½ grs.—0·05 to 1 grm. by subcutaneous or intramuscular injection.
⅛ to ¼ gr.—0·008 to 0·016 grm. by intravenous injection.

ACTION AND THERAPEUTIC USES

It is chiefly used to test the efficiency of the kidneys. A solution is injected intramuscularly and in a normal person excretion of the drug in the urine occurs in about 10 minutes of its administration, colouring it greenish blue. The excretion is complete in about 24 hours, and the total quantity excreted by the kidneys is about 25 per cent. Intravenously its excretion is much quicker.

GROUP XIX

SERA, VACCINES AND TOXINS.

SERA

Serum Antidysentericum (Shiga).—Antidysentery Serum (Shiga). It is a preparation, containing immune substances, which have a specific therapeutic value, when injected into persons infected by Bacillus Dysenteriœ (Shiga). It occurs as a yellow or yellowish-brown transparent liquid, acquiring with age a faint opalescence.

Dose—4,000 to 10,000 units by injection.

Serum Antipneumococcicum I.—It is serum or a preparation from serum, containing the immune substances which have a specific therapeutic action, when injected into persons suffering from certain diseases due to *Diplococcus pneumoniæ* (type I).

Dose—50,000 to 150,000 units by intravenous injection.

Serum Antipneumococcicum II.—Description and doses are the same as for Antipneumococcus serum (type I) with the modification that suitable strains of *Diplococcus pneumoniæ* (type II) are used in the preparation.

Antitoxinum Diphthericum.—Diphtheria Antitoxin Serum. It is a serum or a preparation from serum, containing the antitoxic globulins which have the specific power of neutralising the toxins formed by *Coryne Bacterium Diphtheræ*. It occurs as a yellow, or yellowish-brown or greenish, transparent liquid, acquiring with age a faint opalescence.

Dose—500 to 1,000 units as prophylactic } By injection.
10,000 to 20,000 units as therapeutic }

Antitoxinum Tetanicum.—Tetanus Antitoxin is serum of a preparation from serum containing the antitoxic globulins which have the specific power of neutralising the toxin formed by Bacillus Tetani.

Dose—1,000 to 2,000 units as prophylactic } By injection.
20,000 to 40,000 units as therapeutic }

Antitoxinum Welchicum.—Gas-gangrene Antitoxin (perfringens). Is serum, or a preparation from serum, containing the antitoxic globulins which have the specific power of neutralising the toxins formed by *Bacillus perfringens* (*Bacillus Welchii*).

Dose—4,000 units as prophylactic }
10,000 to 20,000 units as therapeutic } By injection.

Antitoxinum œdematiens.—Gas-gangrene Antitoxin (œdematiens). It is serum, or a preparation from serum, containing the antitoxic globulins which have the specific power of neutralising the toxin formed by the *Clostridium œdematiens*.

Dose—20,000 units as prophylactic injection }
50,000 units as therapeutic injection } daily.

Antitoxinum Vibriosepticum.—Gas-gangrene Antitoxin (Vibrion Septique) is serum, or preparation of serum, containing the antitoxic globulins which have the specific power of neutralising the toxin formed by the *Clostridium*, commonly known as Vibrion Septique.

Dose—5,000 units as prophylactic injection.
10,000 to 20,000 units as therapeutic injection.

Antitoxinum Staphylococcicum.—Staphylococcus Antitoxin. It is a serum, or a preparation from serum, containing the antitoxic globulins which have the specific power of neutralising the toxin formed by certain strains of *staphylococcus*.

Dose—5,000 to 20,000 units by injection.

ACTION AND THERAPEUTIC USES

Serum Therapy consists in the use of the blood serum of an animal, commonly a horse, rendered insusceptible (immune) to a particular disease. Immunization of an animal is brought about by injecting into it gradually increasing doses of such killed or live pathogenic bacteria, which do not excrete their toxin, or of soluble toxin excreted by micro-organism in artificial culture media. As a result of these injections, certain protective substances called "Immune bodies" are formed in the blood, which are capable of acting either on the bacteria (antibacterial) or their poisonous products (antitoxic). The animal, after it has attained a high degree of potency to resist their poisonous effects, is bled and the serum collected is made use of for the cure of the infectious disease for which the animal was immunized. When these antibacterial or antitoxic sera are injected for therapeutical purpose into human beings, they carry into the system the immune bodies contained in them and are capable of exerting a curative or protective influence. In curative doses, sera act either by destroying the micro-organism causing the disease or by antagonising the action of their poisonous products. In prophylactic doses, the blood is endowed with the property of preventing the infection by similar action, and the immunity thus obtained by an individual is called *passive immunity*. It is of short duration and lasts only for a few weeks or months. Examples of antibacterial sera are to be found in the sera used in the treatment of pneumonia, plague, bacillary dysentery, etc., and of antitoxic sera, in the sera used in the treatment or prophylaxis of diseases such as diphtheria, tetanus, gas gangrene, etc.

These sera are all standardized by biological method against a certain amount of the toxin in a standardized preparation and their potency is measured in terms of units. The potency of the sera is, however, liable to get deteriorated by age, exposure to light and heat. The dosage of sera is determined not by the age and sex of the patient but by the nature, stage and severity of the disease and according as they are used for curative or prophylactic purposes. Sera are administered intramuscularly, intravenously, intrathecally, subcutaneously or intradermically, according to requirements. Administered orally or per rectum, they are in most cases ineffective. For use, these sera are put in sealed containers on the label of which the number of units contained in the quantity in each is mentioned. The date after which the preparation is not intended to be used is also stated.

Serum Disease.—In spite of their normal action of neutralising the toxins, the administration of sera in certain cases results in the development of local rashes, redness, and pruritus at the site of injection, and is sometimes accompanied by more generalised symptoms of malaise, urticaria, fever, pain in the joints and enlargement of the lymph glands. These symptoms are seldom severe and are prevented or absorbed by the free use of calcium lactate.

Anaphylaxis or Allergy.—In a small percentage of individuals the administration of serum (Foreign Proteins) results in the development of alarming reactions consisting of pallor, prostration, weak pulse, cyanosis and rise of temperature, developing within half to three hours of injection and lasting several minutes and gradually regressing to normal after a sweat. This may occur at the very first injection of serums ; more generally it occurs at a subsequent stage, especially when the latter is given at an interval of ten days and over after the first. In these cases the individual is either supersensitive to foreign protein introduced into the system in the form of serum, or rendered so after the first dose. This state of super-sensitivity is known as *anaphylaxis* or more correctly *allergy*. A second injection of serum given well within ten days of the first dose is not attended by any untoward symptoms, but rather tends to lessen the sensitivity of the individual to further treatment. In unknown or doubtful cases, the existence or otherwise of this state can be ascertained by injecting a minute dose of the serum intradermally. In positive cases, reaction is obtained by the development of an urticarial wheel or redness at the site of injection after a short interval. Such individuals can be desensitized by subcutaneous injections of small doses of the serum at short intervals prior to the administration of the therapeutic dose.

VACCINES

Vaccinum Vacciniæ.—Vaccine Lymph. It is the preparation of the substance which is obtained from the vesicles produced by inoculation of Vaccinia Virus on the skin of healthy animals. It is prepared with precautions to exclude bacterial contamination as far as possible; and it is preserved with glycerine or other disinfectant. It occurs as a viscid, colourless liquid, containing opaque white matter in suspension.

Dose—1 m. to 0·06 mil. by scarification.

ACTION AND THERAPEUTIC USES

Vaccine Lymph is used as a protective against small pox. Its effectiveness depends on the presence of a living organism which has not been identified. This organism will remain active in glycerinated lymph for several months, if stored in a cool dark place.

Technique for Vaccination.—Vaccination or inoculation of the lymph is done by rubbing the lymph into scarifications made on the cutaneous surface that has been previously made sterile. The scarifications are made deep enough to open the lymph channels and not deep enough to draw blood. Another method of vaccination is to scarify through the lymph previously applied to the skin. Scarification is done by any sharp pointed knife or by special instruments invented for the purpose and should be in the form of parallel lines close to each other covering an area not more than one-eighth of an inch square. Multiple vaccinations at the same time affords a greater protection from small pox than a single one.

Progress of Vaccination.—The immediate effect of vaccination is the irritation which results from inoculation, and subsides within a few hours. If the vaccination is successful, or " takes " as it is called in popular language, it is followed in about three or four days by a small papule with itching and burning sensation. This papule, in about two days of its appearance, changes into a vesicle with an inflamed area around it, and is accompanied by constitutional symptoms of fever, restlessness and discomfort. These symptoms subside when the vesicle reaches its full size with a sharply raised edge and depression in the centre. The neighbouring lymphatic glands get enlarged and tender. The total course of vaccination upto this limit is about nine to ten days. If the vesicle is well protected and not allowed to get contaminated by extraneous matter, it gradually dries into a scab, which falls off in about two weeks of inoculation, exposing a small circular depressed area which soon forms into a depressed scar, the presence of which is required by many health boards as an evidence of successful vaccination.

Vaccinum Typho-Paratyphosum.—Anti-typhoid-paratyphoid Vaccine. *Synonym.*—T. A. B. Vaccine. It is a sterile suspension of the micro-organisms Bacillus Typhosus, Bacillus Paratyphosus A, and Bacillus Paratyphosus B, which have been killed. It contains in 1 millilitre 1,000 million Bacillus Typhosus, 500 million Bacillus Paratyphosus A, and 500 million Bacillus Paratyphosus B. It is a colourless, opalescent liquid which should not be used later than 18 months after preparation.

Dose—8 ms.—0·5 mil. First dose.
15 ms.—1 mil. Second dose after 7 or 10 days interval.

ACTION AND THERAPEUTIC USES IN GENERAL

Bacterial Vaccines are sterile suspensions of killed bacteria in physiologic salt solution. They are standardized by counting, and are designated by name and number. They are killed by heat, diluted to a definite strength and preserved with an antiseptic. They are curative as well as prophylactic. The dosage of the vaccines depends on the number of bacterial bodies contained in a unit quantity, generally 1 c.c. of the suspension.

Theory of preventive immunization.—The object of injecting killed bacteria (Vaccine) into the body is to start into action the same physiological functions as are exerted by the body when resisting disease. The killed bacteria, which are unable to multiply in the tissues, are incapable of causing disease; yet the body exerts the same force to destroy and remove these killed bacteria as it would do to combat the living organism in the usual course of the disease. On account of the injection of the killed bacteria, the patient acquires an immunity against attacks of the same micro-organisms, in the same way as though he had survived a natural attack of the disease.

Action of Vaccines in general.—Injection of killed bacteria in the healthy tissues stimulates the cells of the body to form specific antibodies, in excess of the amount needed to destroy the killed bacteria, and entering the blood stream, they are carried to the site of infection, where they assist in destroying the living bacteria causing the disease. The production of these antibodies goes on for some time after inoculation, so that the acquired resistance lasts much longer than the passive immunity imparted by the injection of an alien immune serum. The principle of activity stimulating an individual to produce his own immune bodies is called *active immunity*. In prophylaxis by serum or antitoxin injection, protection disappears as soon as the immune serum is excreted by the body. This usually occurs within 2 or 3 weeks, while the protection afforded by the injection of vaccine may last for 6 to 8 months or over. The disadvantage of vaccines, however, is that they do not afford immediate protection as an interval of several days or even weeks elapses between inoculation and the production of antibodies. They are, therefore, useful in the treatment of infectious diseases of a chronic nature, and their use is based upon the same principle that call for their use for prophylactic purposes. In lingering local infections of the skin, mucous membranes, bones and joints, it may be that at the point of infection, tissue cells are unable to produce sufficient antibodies to destroy the infecting bacteria. In these cases, it is advisable to stimulate the patient to form his own antibodies by the injection of killed bacteria. All vaccines, when injected, produce either local or focal and systemic effects. Local reactions consist of redness and tenderness at the site of injection and a certain amount of activation of the original focus of disease if one exists; the effects are severe if the dose of the vaccine is large.

The general or systemic effects are manifested by headache, chill, fever, pain and sometimes joint pains. This reaction generally passes off within about forty-eight hours.

TOXINS

Toxinum Diphthericum Diagnosticum.—Diphtheria Diagnostic Toxin. *Synonym.*—Schick Test Toxin. It is a reagent used for determining the susceptibility of the individual to diphtheria. It is distributed in the diluted or undiluted form in sterile containers, so as to exclude bacteria. The undiluted form is a yellow liquid free from particles. The diluted form is a clear, colourless liquid.

Dose—3 ms.—0·2 mils. by intradermal injection.

Toxinum Diphthericum Calefactum.—Heated Diphtheria Toxin. *Synonym.*—Schick Control. It is prepared from the same batch of Schick Test Toxin as that with which it is issued for use by heating Schick Test Toxin to a temperature of not less than 70° for not less than five minutes. It is a control test to be used simultaneously with Schick Test Toxin to exclude the non-specific skin reactions which sometimes occur with the latter reagent.

Dose—3 ms.—0·2 mil. by intradermal injection.

Toxinum Diphthericum Detoxicatum.—Detoxicated Diphtheria Toxin. *Synonym.*—Diphtheria Prophylactic. It is a toxin the specific toxicity of which is reduced to a minimum without rendering it inefficient as an immunising agent.

It is favourable for use in a variety of forms.

Dose—The volume is indicated on the label as the dose, on two or three occasions, at intervals of two to four weeks. Given by subcutaneous injection.

Toxinum Tetanicum Detoxicatum. *Synonym.*—Tetanus Toxoid. Tetanus-toxin. It is a toxin the specific toxicity of which has been completely removed by the action of chemical substances without rendering it inefficient as an immunising agent. Tetanus Toxoid may occur in simple solution or atum precipitated.

Dose—8 to 15 ms.—0·5 to 1 mil. by subcutaneous or intramuscular injection.

ACTION AND THERAPEUTIC USES

Minute doses of diphtheria and other toxins, introduced intracutaneously, produce positive reaction which is manifested by local redness when insufficient antitoxin is present in the blood serum. This local reaction reaches its maximum in 48 hours and then slowly fades away. A negative reaction always indicates that the person is protected against the disease produced by a particular toxin. It is due to the presence of anti-toxin in sufficient quantity for prophylaxis.

Diphtheria prophylactic is used as an active immunising agent in persons exposed to the risk of it. Its injection may cause local and general reactions lasting only for two or three days. These reactions consist of induration with an area of redness extending several inches around the site of injection, together with malaise, headache and fever.

Tetanus Toxoid when injected into animals it produces tetanus antitoxin in the circulating blood, or increases the amount of this antitoxin, if already present.

Tuberculinum Pristinum.—Old Tuberculin. It is the concentrated filtrate from a fluid medium on which Bacillus Tuberculosis has been grown. It occurs as a transparent viscous fluid having a yellowish-brown colour, with an odour like that of honey. The suffix T or PT, after the Old Tuberculin denotes the first case that the Old Tuberculin is prepared by growing the human type of bacilli, and in the second case it is suggestive of Old Tuberculin prepared by growing the bovine type of bacilli. It is given by subcutaneous injection.

Dose—$\frac{1}{60}$ to $\frac{1}{12}$ m.—**0·001 to 0·005 mil.** for diagnostic purposes.

$\frac{1}{60000}$ **m.** gradually increased. **0·000001 mil.** gradually increased. For therapeutic purposes.

ACTION AND THERAPEUTIC USES

Tuberculin was first introduced as a remedial agent by Robert Koch in 1890. The first form which he used was one grown on a fluid medium containing 5 per cent. of glycerine, but later on as other preparations were introduced, this was termed "Old Tuberculin." Other preparations are suspensions of the ground up bacilli, *e.g.*, Tuberculin Residue (T.R.) and Bacillus Emulsion (B.E.) All these Tuberculins are identical in actions and properties and are used similarly both for diagnosis and treatment. The tuberculins differ from the true toxins in having no power to induce the formation of antibodies in healthy or non-tuberculous subjects, and produce no reactions in them even in large doses, while in subjects of active or latent tuberculous infection, even in minute doses, they produce a characteristic tuberculin reaction which is local, focal and systemic. The local reaction shows itself as redness, œdema, and soreness at the site of injection, and is used for diagnostic purposes, especially in young persons. It is of little value in adults, as practically all persons react positively.

The focal reaction in pulmonary tuberculosis, is manifested, by increased cough, expectoration, pleuritic pains and aggravation of the physical signs, and if larynx is involved, hoarseness, pain and aphonia. In bone tuberculosis, there is increased pain and stiffness; in open sinuses, it is manifested by augmentation of the discharge.

Systemic reaction is characterised by a rise in temperature with malaise, headache and anorexia, and it comes within a few hours and lasts for a day or so.

PART V

Identification of Drugs

Of the many substances which are officially used as medicine, only a few can be identified from their unlabelled specimens with the help of our physical organs of sense. Students, however, must be familiar with such specimens of drugs by a practical study of them, as the identification of drugs forms part of their practical examination. The combination of the sense of sight, of smell and of touch will greatly help a student to master the details and peculiarities of such specimens ; and that can be further aided by the sense of taste. The sense of taste, however, must be cautiously used, as some of the substances are of a poisonous nature. Apart from the crude vegetable drugs, which form an independent group by themselves for identification, all medicinal substances can be classified into solids, semi-solids and liquids. Solids may be in the form of masses either crystalline, non-crystalline or agglutinated ; or powders, coloured and uncoloured. Liquids may be either oily or watery. Semisolids may be plastic or viscid.

MEDICINAL SUBSTANCES

SOLIDS

MASSES OR LUMPS

A. Crystalline Masses :—

1. **Alumen :** Alum.—Occurs in colourless crystalline masses, or powder ; with a sweetish, astringent taste.

2. **Ammonii Carbonas :** Ammonium Carbonate.—Occurs in hard crystalline masses having a strong pungent odour of ammonia.

3. **Camphorum:** Camphor.—Translucent masses or squares with a characteristic aromatic odour.

4. **Hydrargyri Perchloridum:** Mercuric Chloride.—Heavy colourless or white rhombic, crystalline masses.

5. **Plumbi Acetas:** Lead Acetate.—Heavy crystalline masses, with an acetous odour, and sweetish astringent taste.

6. **Potassii Acetas:** Potassium Acetate.—White foliaceous satiny masses with an acetous odour and sharp saline taste.

7. **Potassa Sulphurata:** Sulphurated Potash.—Solid fragments of greenish-yellow colour, with an odour of hydrogen sulphide.

B. Non-crystalline Masses:—

1. **Arsenii Trioxidum:** Arsenic Acid.—Heavy stratified opaque irregular lumps or opaque white heavy powder.

2. **Cera Alba:** White Beeswax.—A yellowish white solid, translucent in thin layers with a faint characteristic odour.

3. **Cera Flava:** Yellow Beeswax.—A yellowish-brown solid, with an agreeable honey-like odour. Fracture granular.

4. **Oleum Theobromatis:** Oil of Theobroma.—A yellowish-white solid fat, with a slight agreeable odour of cocoa.

5. **Paraffinum Durum:** Hard Paraffin.—A white translucent mass showing crystalline structure. Greasy to touch.

C. Agglutinated Masses.—These are generally coloured substances of vegetable origin.

1. **Acacia:** Gum Acacia.—Rounded ovoid tears. (A solid transparent exudation from the stem or branches of a tree). Varying in size from a pea to a hazel nut, colourless or pale-yellow; opaque in colour from the presence of numerous minute fissures and mucilaginous in taste.

2. **Aloe:** Hard: dark or chocolate brown opaque masses, breaking with a dull waxy uneven, often porous fracture and possessing a strong characteristic unpleasant odour and an extremely bitter taste.

3. **Asafoetida:** An oleo-gum-resin in rounded or flattened tears or lumps, of a dull yellow or dirty grey colour, darkening on keeping. Odour characteristic, strong and alliaceous.

4. **Benzoinum:** Benzoin.—It is a balsamic resin in hard brittle masses consisting of opaque, white tears embedded in dull, greyish brown or sometimes reddish brown matrix, odour agreeable, and taste acrid,

5. **Catechu:** Gambir.—Agglutinated cubes, light in weight, of a dull dark reddish-brown colour, which varies slightly on different sides of the same piece. Porous and easily friable. Taste bitter, astringent and sweetish.

6. **Colophonium:** Resin.—Translucent, pale amber coloured angular, brittle glassy masses, with a faint terebinthinate odour and taste.

7. **Myrrha:** Myrrh.—Rounded or irregular tears, or masses of varying sizes, with a reddish-yellow or brown colour. Easily friable; fractured surface having a translucent, unctuous granular appearance. Odour agreeable and aromatic; taste bitter and acrid.

8. **Opium:** Dried juice in rounded or flattened masses plastic when fresh, becoming hard and brittle by keeping; chestnut brown colour; odour characteristic.

9. **Podophylli Resina:** Resin of Podophyllum. Brownish grey masses with a characteristic odour and a bitter acrid taste.

10. **Scammoniæ Resina:** Resin of Ipomœa.—Brownish translucent brittle fragments, breaking with a resinous fracture. Odour characteristic and agreeable.

CRYSTALS AND SCALES

A. White Crystals (Rhomboidal and Cubic) :—

1. **Chloral Hydras:** Chloral Hydrate.—Rhomboidal, colourless, transparent crystals, with an aromatic penetrating acid odour.

2. **Potassii Bromidum:** Potassium Bromide.—Faintly brownish translucent cubic crystals, with a pungent saline taste.

3. **Potassii Iodidum:** Potassium Iodide.—Colourless translucent cubic crystals, with a saline bitter taste.

4. **Thymol:** Colourless crystals, with a pungent aromatic thyme-like odour and taste.

B. White Crystals (Acicular or Needle-shaped) :—

1. **Acidum Benzoicum:** Benzoic Acid.—Colourless, light feathery crystals with a faint balsamic odour.

2. **Magnesii Sulphas:** Epsom Salt.—Small colourless prismatic needles with a bitter saline taste.

3. **Menthol:** Acicular or thin prismatic crystals with an odour and taste of peppermint.

4. **Phenol :** Carbolic Acid.—Needle-shaped, deliquescent, pinkish crystals with a characteristic tarry odour.

5. **Quininæ et Æthylis Carbonas :** Quinine Ethyl Carbonate.—Fine, soft, white matted needles ; almost tasteless ; light in weight.

6. **Quininæ Sulphas :** Quinine Sulphate.—Soft silky filiform crystals or hard prismatic needles, very bitter in taste.

7. **Zinci Sulphas :** Zinc Sulphate.—Thin rhombic crystals closely resembling crystals of magnesium sulphate. Metallic in taste.

C. Coloured Crystals and Scales :—

1. **Arsenii Triodidum' :** Arsenic Iodide.—Small orange coloured crystals without any odour.

2. **Chromii Trioxidum :** Chromium Trioxide.—Dark red acicular crystals or dark-brown masses. Deliquescent and corrosive.

3. **Cupri Sulphas :** Copper Sulphate.—Blue triclinic crystals.

4. **Ferri Sulphas :** Iron Sulphate.—Transparent green crystals with a metallic and an astringent taste.

5. **Iodoformum :** Iodoform.—Small, shining, lemon coloured crystals. Soapy to touch. Odour characteristic, persistent and disagreeable.

6. **Iodum :** Iodine.—Bluish-black rhombic prisms or plates, with a characteristic pungent odour. Very volatile, colouring the bottle with crimson vapours.

7. **Potassii Permanganas :** Potassium Permanganate.—Dark purple prismatic crystals, with a metallic lustre.

8. **Ferri et Ammonii Citras :** Iron and Ammonium Citrate. Thin dark red transparent deliquescent scales with an astringent taste.

9. **Ferri et Quininæ Citras :** Iron and Quinine Citrate.—Thin greenish-yellow scales, with a bitter chalybeate taste.

FLAKES, STRIPS AND SHEETS

1. **Agar :** Agar-agar.—Occurs in long flattened yellowish white translucent strips as thick as a straw or as greyish-white powder. Swells to a gelatinous mass when immersed in water.

2. **Gelatinum :** Gelatin.—Occurs in yellowish, translucent sheets or shreds with a faint odour and slight taste.

3. **Tragacantha :** Tragacanth.—Occurs in thin flattened translucent ribbon shaped flakes ; horny in appearance and yellowish-white in colour. They are odourless and tasteless.

PENCILS OR CYLINDRICAL RODS

1. **Argentii Nitras Induratus:** Toughened Silver Nitrate. White or greyish-white, cylindrical rods, generally wrapped up in blue paper.

2. **Potassii Hydroxidi:** Caustic Potash.—White sticks or fused masses very deliquescent, strongly alkaline and corrosive.

3. **Zinci Chloridi:** Zinc Chloride.—Opaque white sticks or masses ; very deliquescent. Acid in reaction.

POWDERS

A. White Coloured :—

1. **Bismuth Carbonas:** Bismuth Carbonate.—A creamy-white powder.

2. **Bismuth Salicylas:** Bismuth Salicylate.—White or nearly white, amorphous powder.

3. **Chloramina Chloramine T:** White crystalline powder or crystals with an odour of chlorine. On exposure to air, it decomposes losing chlorine and assumes a yellow colour.

4. **Magnesii Carbonas:** Magnesium Carbonate.

5. **Magnesii Oxidum Leve:** Light Magnesium Oxide.

Both are very light powders.

B. Yellow Coloured :—

1. **Aloinum:** Aloin.—A pale yellow micro-crystalline powder having a faint odour of aloes. Taste intensely bitter.

2. **Chrysarobinum:** Chrysarobin.—A light micro-crystalline brownish yellow powder. Odourless and tasteless.

3. **Hydrargyri Oxidum Flavum:** Yellow Mercuric Oxide. A yellow amorphous heavy powder. Assumes a red colour when heated.

4. **Orthocaina:** Orthocaine.—A faintly yellow crystalline powder, odourless and tasteless.

5. **Podophylli Resina:** Resin of Podophyllum.—An amorphous powder varying in colour from pale yellow to yellowish brown or in brownish grey masses. Odour characteristic; taste bitter and acrid.

6. **Sulpharsphenamina:** Sulpharsphenamine.—A pale-yellow powder in a sealed glass container.

7. **Sulphur Precipitatum:** Precipitated Sulphur.—A soft nongritty, pale-yellow amorphous powder.

8. **Sulphur Sublimatum:** Sublimed Sulphur.—Greenish-yellow gritty powder with a characteristic odour.

C. Red or Orange Coloured :—

1. **Acriflavina:** Acriflavine.—An orange red or brownish red cystalline powder.

2. **Fluoresceinum Solubile:** Soluble Fluorescein.—An orange red powder, odourless and tasteless.

3. **Hydrargyri Iodidum Rubrum:** Mercuric Iodide.—A scarlet red powder.

4. **Plumbi Monoxidum:** Lead Monoxide.—Pale orange or brick-red heavy powder or scales.

D. Grey Coloured :—

1. **Bismuthum Præcipitatum:** Precipitated Bismuth.—A dull grey powder easily diffusible in water.

2. **Ferri Sulphas Exsiccatus:** Exsiccated Ferrous Sulphate.—A greyish-white powder.

3. **Ferrum Redactum:** Reduced Iron.—A fine greyish-black powder free from metallic lustre.

4. **Hydrargyri cum Creta:** Grey Powder.—Grey, non-gritty rather damp powder.

E. Green Coloured :—

1. **Ferri Carbonas Saccharatus:** Saccharated Iron Carbonate. An olive brown, slightly hygroscopic powder, with a feebly chalybeate taste.

2. **Methylthioninæ Chloridum:** Methylene Blue.—A dark-greenish crystalline powder with a metallic lustre or a dull dark-green or brown powder; almost odourless.

3. **Pulvis Glycyrrhizæ Compositus:** Compound Powder of Liquorice.—A greenish-yellow powder with an odour of fennel.

F. Blue Coloured :—

1. **Indicarminum:** Indigocarmine.—A blue powder or blue granules with a coppery lustre.

G. Brown or Buff Coloured :—

1. **Acidum Tannicum:** Tannic Acid.—Yellowish white or light-brown glistening scales or powder, with an astringent taste.

2. **Quininæ Tannas :** Quinine Tannate.—A pale-yellow or yellowish-white amorphous powder, with an astringent but slightly bitter taste.

PLASTIC MASSES, SEMI-SOLIDS

A. Plastic Masses :—

These are generally brownish-black pill masses, some of which are distinguishable from the smell of the volatile oil they contain and the colour.

1. **Pilula Aloes :** Pill of Aloes.—Has a smell of oil of Caraway.
2. **Pilula Aloes et Asafœtidæ :** Pill of Aloes and Asafœtida. Has a smell of Asafetida.
3. **Pilula Colocynthidis et Hyoscyami :** Pill of Colocynth and Hyoscyamus.—Has a smell of oil of Cloves.
4. **Pilula Hydrargyri :** Blue Pill.—The mass has a blue colour.
5. **Pilula Rhei Compositum :** Compound pill of Rhubarb.—Has a smell of Oil of Peppermint.

B. Semisolids or Viscid Liquids :—

1. **Balsamum Peruvianum :** Balsam of Peru.—Dark or reddish-brown viscid liquid with an agreeable balsamic and vanilla-like odour.
2. **Balsamum Tolutanum :** Balsam of Tolu.—A soft tenacious, yellowish-brown mass not soft enough to flow. Hardens into a brown brittle mass ; odour aromatic vanilla like.
3. **Copaiba :** A yellow or brownish yellow viscous liquid with a slight but distinct green fluorescence. Odour aromatic and characteristic. Taste acrid and bitter.
4. **Ichthammol :** An almost black viscid liquid with a strong and characteristic odour.
5. **Pix Liquida :** Tar.—A dark brown or blackish semi-liquid substance. Odour characteristic and empyreumatic.
6. **Styrax :** Storax.—A brown viscous substance with an agreeable aromatic balsamic odour.

LIQUIDS

A. Oils :—

1. **Oleum Abietis :** Oil of Siberian Fir.—A pale yellow liquid, with a pine odour.

2. **Oleum Anethi**: Oil of Dill.—A colourless or pale yellow liquid darkening with age. Odour of fennel fruit; taste sweet and aromatic.

3. **Oleum Anisi**: Oil of Anise.—A pale yellow liquid, with an odour of anise fruit, taste sweet and aromatic.

4. **Oleum Cadinum**: Oil of Cade.—Reddish brown or nearly black oily liquid, with empyreumatic odour.

5. **Oleum Cajuputi**: Oil of Cajuput.—A colourless or yellow liquid, with camphoraceous odour. Commercial oil of cajuput is of a green colour due to copper.

6. **Oleum Cari**: Oil of Caraway.—A pale yellow liquid, with an odour of caraway fruit.

7. **Oleum Caryophylli**: Oil of Cloves.—A pale yellow liquid darkening with age or exposure to air. Odour and taste those of cloves.

8. **Oleum Chinopodii**: Oil of Chinopodium.—A pale yellow liquid, with a characteristic and unpleasant odour, and bitter and burning taste.

9. **Oleum Cinnamomi**: A yellowish liquid gradually becoming reddish-brown with age. Odour and taste those of Cinnamon.

10. **Oleum Coriandri**: Oil of Coriander.—A pale yellow liquid, with an odour and taste of coriander.

11. **Oleum Eucalypti**: Oil of Eucalyptus.—A colourless or pale yellow liquid. Odour aromatic and camphoraceous.

12. **Oleum Hydnocarpi**: Hydnocarpus Oil.—A yellowish or brownish yellow oil or soft cream coloured fat. Odour characteristic and taste acrid.

13. **Oleum Lavendulæ**: Oil of Lavender.—A pale yellow or yellowish green liquid, with an agreeable odour of the flowers.

14. **Oleum Limonis**: Oil of Lemon.—A pale yellow or greenish yellow liquid, with an odour of lemons.

15. **Oleum Lini**: Linseed Oil.—A yellowish-brown oil, with a characteristic odour.

16. **Oleum Menthæ Piperitæ**: A colourless, pale-yellow or greenish-yellow liquid, with an odour of peppermint; taste pungent and aromatic, followed by a sensation of cold.

17. **Oleum Morrhuæ**: Cod-liver Oil.—A pale-yellow or reddish-brown liquid, with a fishy odour and taste.

18. **Oleum Myristicæ**: Oil of Nutmeg.—A pale-yellow viscid liquid, with an odour of nutmeg.

19. **Oleum Ricini**: Castor Oil.—A pale-yellow viscid liquid, with a characteristic odour.

20. **Oleum Rosmarini:** Oil of Rosemary.—A pale-yellow liquid, with an odour of rosemary.

21. **Oleum Santali:** Oil of Sandalwood.—A colourless or pale-yellow viscous liquid, with an odour of sandalwood.

22. **Oleum Terebinthinæ:** Oil of Turpentine.—A colourless limpid liquid, with a characteristic smell.

B. Oily Liquids :—

1. **Acidum Oleicum:** Oleic Acid.—A colourless or yellowish liquid darkening on exposure to air. Odour and taste characteristic..

2. **Acidum Sulphuricum:** Sulphuric Acid.—A colourless Corrosive liquid of oily consistency

C. Watery Liquids :—

1. **Acetone:** A clear, colourless, mobile liquid, with a characteristic odour and pungent sweetish taste.

2. **Acidum Aceticum:** Acetic Acid.—A clear liquid, with a pungent odour.

3. **Acidum Hydrochloricum:** Hydrochloric Acid.—A colourless fuming liquid, with a pungent odour.

4. **Acidum Hydrocyanicum Dilutum:** Dilute Hydrocyanic Acid.—A colourless liquid, with a peach-like odour.

5. **Acidum Nitricum:** Nitric Acid.—A clear colourless liquid emitting corrosive fumes.

6. **Æther:** Ether.—A colourless, transparent mobile liquid, with a characteristic odour. Taste sweet and burning; very volatile and inflammable.

7. **Amylis Nitris:** Amyl Nitrite.—A clear yellow liquid, with a fragrant odour, kept generally in glass capsules.

8. **Chloroformum:** Chloroform.—A colourless volatile liquid, with a characteristic odour and sweet pungent taste.

9. **Liquor Ammoniæ Fortis:** Strong Solution of Ammonia.—A colourless liquid, with a strong pungent odour of Ammonia and strong alkaline reaction.

10. **Liquor Cresolis Saponatus:** Solution of Cresol with Soap.—An amber coloured to reddish-brown liquid, with an odour of cresol; soapy to touch.

11. **Liquor Epispasticus:** Blistering Liquid.—A faint yellowish liquid, with an odour of acetone.

12. **Liquor Formaldehydi:** Solution of Formaldehyde.—A colourless liquid, with a characteristic pungent and irritating odour.

13. **Lotio Hydrargyri Nigra:** Black-wash.—A watery liquid, with blackish-grey deposit.

14. **Paraldehydum:** Paraldehyde.—A colourless liquid, with a strong and characteristic odour.

CRUDE VEGETABLE DRUGS

Crude vegetable drugs which form the source of many preparations of the B. P. can be classified into Roots, Rhizomes, Tubers, Bulbs, Corms, Woods, Leaves, Herbs, Flowers, Petals, Fruits, and Seeds.

ROOTS

1. **Belladonnæ Radix:** Belladonna Root.—A cylindrical entire or longitudinally split root. Externally pale greyish-brown in colour, finely wrinkled longitudinally; internally whitish or brownish. Its firm plump appearance is characteristic.

2. **Calumba:** Calumba Root.—Flat irregularly circular or oval slices depressed towards the centre. Dark greyish-brown and wrinkled. Transverse surface is of a dull yellowish colour towards the margin of the wood.

3. **Gentiana:** Gentian Root.—Nearly cylindrical pieces of varying lengths but seldom exceeding 2·5 centimeters or about ¾ inch in thickness. Externally yellowish-brown in colour, much shrivelled and wrinkled longitudinally. Transverse surface is of a reddish brown colour and spongy.

4. **Glycyrrhiza:** Liquorice.—It is a peeled root nearly cylindrical, with pale-yellow fibrous surface. Transverse section is fibrous and of a lemon-yellow colour.

5. **Ipecacuanha:** Ipecacuanha Root.—It is a dark-brown slender tortuous root closely annulated externally. Transverse section shows a thick bark and a small uniformly dense wood.

6. **Krameria:** Rhatany Root.—A nearly cylindrical root about 15 millimetres, *i.e.*, about ½ inch in thickness. External surface is rugged scaly, reddish-brown in colour. Transverse surface exhibits a pale-reddish or yellowish wood, with a narrow reddish-brown bark.

7. **Senega:** Senega Root.—It is a slender, greyish or brownish-yellow root, frequently curved or contorted, with a knotty crown having numerous buds and bases of slender aerial stems. Transverse section exhibits a whitish wood and yellowish horny bark.

RHIZOMES

1. **Filix Mas:** Male Fern.—A rhizome entirely covered with curved, angular, dark-brown bases of the petioles ; transverse section is of a yellowish-green colour. Taste astringent, bitter and nauseous.

2. **Zingiber:** Ginger.—It is a buff coloured, laterally compressed, fibrous rhizome, having short, flattish, obovate, oblique branches, with a depressed scar indicating the point of attachment of an aerial stem. Fractured surface shows protruding fibres and yellow oil cells.

3. **Podophyllum:** It is a cylindrical, smooth or wrinkled longitudinally rhizome, which is at interval enlarged to bear on its upper surface a concave scar surrounded by several circular scars left by the aerial flowering stem and its leaves. On the under surface of the stem are seen scars of several stout roots.

4. **Rheum:** Rhubarb.—It is a compact, firm, cylindrical or barrel shaped rhizome covered with bright, brownish-yellow powder. Transverse section shows at the periphery a ring of starlike spots.

5. **Serpentaria:** Serpentary.—A dull yellowish-brown slender rhizome having on the under surface numerous wiry roots.

6. **Valeriana:** Valerian.—It is a short erect yellowish-brown rhizome surrounded by numerous roots. Internally it is firm, horny, and of a whitish colour.

TUBERS, BULBS AND CORMS

1. **Aconitum:** Aconite.—It is a thick elongated conical root dark-brown in colour. At the upper extremity it is crowned with a scar of an aerial stem and scars of numerous thick rootlets. Transverse section exhibits a thick bark separated from an inner portion by a dark stellate line.

2. **Jalapa:** Jalap.—Hard, compact heavy tuberous root; fusiform in shape. The outer surface is dark-brown, furrowed, wrinkled and marked with numerous paler elongated transverse scars. (lenticels). Internally yellowish-grey to dingy brown.

3. **Scilla:** Squill.—Large tunicated bulb divested of its dry membranous covering. In commerce, it consists of narrow, flattish, curved strips tapering at both ends. In colour, they are yellowish-white, more or less translucent.

4. **Colchici Cormus:** Colchicum Corm.—Fresh corm is conical, flattened on one side, enveloped in a yellowish-brown membranous coat. In commerce, it occurs in transverse slices, dried by gentle

heat, yellowish on the outer surfaces and renniform in outline. The depression corresponds to the position of the flower. Transverse surface exhibits numerous scattered darker points. Bitter in taste.

WOODS

Quassia: Quassia Wood.—Occurs in chips, raspings or shavings; occasionally in cubes or logs. It is yellowish-white or bright yellow in colour, light, rather dense and easily split. Taste intensely bitter.

BARKS

1. **Aurantii Cortex Siccatus:** Dried Bitter Orange Peel. Thin narrow strips with dark orange-red rough pitted outer surface. Inner surface white and spongy.

2. **Cascara Sagrada:** Occurs in straight, stiff, single quills or channelled pieces. Outer surface is smooth, dark, purplish in colour and marked with transversely elongated whitish lenticels. Inner surface is of a dark-reddish brown colour and longitudinally striated with faint transverse corrugations. It has a characteristic odour and persistent bitter taste.

3. **Cinchona:** Red Cinchona Bark —Occurs in quills or curved pieces of variable size. Outer surface is rough and of a dull dark grey or dull brownish colour marked with whitish patches of lichen. Inner surface is of a dull brown colour with a reddish tinge. Taste bitter and astringent.

4. **Cinnamonum:** Cinnamon.—Occurs in long slender channelled pieces or in single or compound quills. Outer surface is dull yellowish-brown marked with pale wavy longitudinal lines with occasional small scars or holes. This bark has no cork. Inner surface is rather darker than the outer and finely striated longitudinally. It has a fragrant odour and a warm sweet aromatic taste.

5. **Prunus Serotina:** Wild Cherry Bark.—It has a smooth glossy reddish-brown cork much interrupted by transversely elongated lenticels. If the cork has been removed, the bark is of a greenish-brown colour irregularly reticulated or fissured. Taste is astringent bitter and aromatic, resembling that of bitter almonds.

6. **Quillaia:** Occurs in flat pieces, the outer surface of which is of a pale-brownish or yellowish-white colour streaked with reddish-brown patches of imperfectly removed outer portion. The inner surface is smooth, white or yellowish-white. Its fracture is splintery.

LEAVES

A. Large in size :—

1. **Belladonnæ Folium :** Belladonna Leaf.—Light green broadly ovate, acute, entire leaves tapering towards the base. The mid-rib and lateral veins are prominent on the under surface. Specimen leaves are generally in a crumpled mass thin, papery and brittle. They are of a dull green colour, paler on the under surface.

2. **Digitalis Folium :** Digitalis Leaf.—It is the largest leaf of the B.P. Broadly ovate or ovate lanceolate with a winged petiole. The upper surface is green and bears numerous short hairs. The lower surface is paler and more or less densely pubescent. The mid-rib is prominent on the under surface and the lateral veins decurrent and form more or less acute angle with it. The margin is crenate ; apex blunt.

3. **Eucalyptus :** Long narrow tapering leaves, ensiform in outline, entire at the margin, and coriaceous in texture, with a similarity between the two surfaces. The mid-rib is distinct and the lateral veins starting from it anastamose at the margin to form a continuous surface. The leaves contain many oil glands, which are best observed by holding the leaf against a strong light.

4. **Hamamelis :** Witch Hazel Leaves.—Broadly ovate or rounded ovate dark-brownish leaves with short petioles. Margin is coarsely crenate or even sinuate. The mid-rib is prominent and the lateral veins which are also distinct, branch at an acute angle and run straight to the margin. At the angle are seen scattered stellate hairs.

5. **Hyoscyamus :** These leaves are pale green in colour having soft hairs on the under surface near the veins ; sticky to touch. The mid-rib is broad and the margins sinuate or dentate.

6. **Stramonium :** Dried leaves are usually much shrivelled or wrinkled. They are of greyish-green colour, triangular in shape with a sinuate dentate outline. The mid-rib is distinct and the veins form with it an angle of 45 degrees. The odour of the drug is disagreeable and characteristic ; taste unpleasantly bitter.

B. Small in size.—

1. **Buchu :** Rhomboid-ovate, rigid coriaceous leaves with a greenish-yellow colour and sharply denticulate margin containing oil glands at the base of each marginal indentation. The apex of the leaves is generally blunt and recurved. The odour and taste are characteristic.

2. **Sennæ Folium:** Senna Leaf.—It is a pale-green lanceolate to ovate-lanceolate leaf with an entire margin and acute apex. The leaves are decidedly unequal at the base. The veins are distinct on the under surface. There are scattered hairs on both surfaces.

FLOWERS

1. **Caryophyllum:** Clove.—It is a flower bud consisting of a solid fleshy, nearly cylindrical reddish-brown portion of the ovary, crowned by four thick divergent, calyx teeth of the similar colour; from the centre of the calyx arise four pale-brown, unexpanded intricated petals. The fleshy portion is spongy and contains a large number of oil glands at the periphery.

HERBS AND SUBSTANCES REPRESENTING A PART OF THE PLANT

A. Herbs :—

1. **Agar:** Agar-Agar.—Occurs in long yellowish-white translucent strips as thick as a straw or as a greyish white powder.

2. **Lobelia:** It is a stem with a hairy and winged rounded or channelled stems having a green or purplish tint. The leaves are pale green alternate toothed and hairy on their under surface. Capsules are inflated, ovoid, and contain numerous brown seeds. Odour slight, somewhat, irritating ; taste burning and acrid.

B. Fruits and Fruit Parts :—

1. **Anethum:** Dill Fruit.—It is a tiny fruit broadly ovate, flat and brown in colour. Traversed by ridges of which the two lateral ones are prolonged into thin yellowish membranous wings, forming a distinctive character from fennel and caraway fruit.

2. **Aurantii Cortex Siccatus:** Dried Bitter Orange Peel.—Occurs in thin narrow strips with dark, orange red, pitted outer surface. Inner surface white and spongy.

3. **Capsicum:** Dull orange red, oblong-conical fruit, obtuse at the apex. Sometimes attached to a five-toothed inferior calyx and a straight, slender pedicle. The pericarp is flattened, shrunken, shrivelled, glabrous, shining, thin and leathery. Transverse section shows two cells separated by a thin reddish membranous dissepiment. Each cell contains five to ten small flat reniform seeds. It has a characteristic odour and a very pungent taste.

4. **Cardamomum:** Cardamom.—It is a three-sided, ovoid, shortly beaked, rounded at the base capsule of a pale buff or greenish buff colour containing the official seeds which are separated from the

fruits when required for use. The seeds are pale to dark reddish-brown, irregularly angular, transversely wrinkled, whitish within, odour aromatic; taste warm and aromatic.

5. **Carum** : Caraway Fruit.—It is a small brown-coloured fruit with separate mericarps. The commercial specimens consist entirely of separated mericarps which are narrow, tapering at each end and curved. Each mericarp has five pale longitudinal ridges and on transverse section exhibits six vittæ. Odour, aromatic, and taste spicy and characteristic.

6. **Cassia** : Cassia Pod.—Long narrow cylindrical, shortly stalked fruit, with a dark brown or nearly black thin and hard pericarp. Internally divided by thin transverse dissepiments into compartments, each of which contains a smooth, oval, reddish-brown seed surrounded by a nearly black sweet pulp, which is the only official part of the fruit.

7. **Colocynthis** : Colocynth.—It is a whitish, very light, spongy fruit, occurring in globular masses in which seeds are embedded. It is odourless with an intensely bitter taste.

8. **Coriandrum** : Coriander.—It is a small sized, subglobular fruit, of a uniform brownish-yellow colour. It is crowned by calyx teeth and style. It consists of two mericarps united by their margins and enclose between them a small cavity. Each mericarp has wavy primary and straight secondary ridges and has on its commissural surface two brown vittæ. The odour of the bruised fruit is aromatic, and taste agreeable and spicy.

9. **Fœniculum** : Fennel Fruit.—Small ovoid-oblong fruit with a greenish-yellow or brown colour, and crowned with a stylopod. It bears on the outer surface five pale, very prominent primary ridges. Transverse section presents four large vittæ. Odour aromatic; taste aromatic and camphoraceous.

10. **Sennæ Fructus** : Senna Pod. Pale-greenish-brown or brown pods, broadly oblong, flat, thin, and rounded at each extremity. Pericarp is dry and membranous.

C. Seeds :—

1. **Colchici Semen** : Colchicum Seed.—It is a small nearly spherical seed. Very hard, of a dull dark reddish-brown colour, and pointed at the hilum. Taste bitter and acrid.

2. **Ergota** : Ergot.—Though ergot is grouped under seeds, it is a fungus usually $\frac{1}{2}$ to 1 inch in length and about $\frac{1}{16}$ to $\frac{1}{4}$ inch in thickness. It is dark-violet or nearly black in colour. Slender, curved, rounded at both ends and longitudinally furrowed. It is whitish or pinkish white within.

3. **Linum** : Linseed.—Dark-brown elongated, ovoid, flattened seeds, with an acute edge. Smooth and shining; transverse section exhibits a yellow-white oily kernel consisting of two large cotyledons.

4. **Myristica** : Nutmeg.—It is an ovoid kernel about 25 millimetres long. Externally greyish-brown with reticulated furrows. Internal surface exhibits a greyish red marbled appearance. Odour aromatic; taste warm, bitter and aromatic.

5. **Nux-Vomica** : Ash-grey or greenish-grey disc-shaped seeds, 20 to 25 millimetres in diameter and about 4 mm. thick. They are nearly flat or irregularly bent; margin is rounded or somewhat acute. Surface is satiny, due to numerous closely appressed hairs radiating from the centre to the circumference. On one surface, a central scar from which a ridge passes to the margin and ends in a slight prominence.

6. **Strophanthus** : Strophanthus seeds are of an elongated oval shape, acuminate towards the apex and narrowed towards the base which is obtuse. They are flattened and provided on one side with a ridge running from the centre to the apex of the seed. In colour they vary from greyish green to fawn. They are covered with satiny appressed hairs that impart to them a conspicuous shine.

Plant Products :—

This group embraces a variety of products of a very diverse character, such as dried cortex, dried juices, extracts, gums, resin, oils, fats, etc., and for identification purposes these are grouped with solid medicinal substances.

CRUDE ANIMAL DRUGS

1. **Cantharis** : Spanish fly.—It is a beetle with a shining green or coppery green colour. The wings are long and narrow.

2. **Coccus** : Cochineal.—They are small purplish-black or purplish grey insects, with an oval outline, flattish or slightly concave on one side and arched on the other. They scarcely show any resemblance to insect but when macerated in water, they swell considerably and then three pairs of legs can be discerned. They are brittle and are easily reduced to a dark-red powder.

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